Allen-Bradley

Logix5000™ Motion Modules

1756 ControlLogix®,
1789 SoftLogix™

User Manual

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. *Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls* (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.ab.com/manuals/gi) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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Throughout this manual, when necessary we use notes to make you aware of safety considerations.

WARNING

Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

IMPORTANT

Identifies information that is critical for successful application and understanding of the product.

ATTENTION

Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you:

- identify a hazard
- avoid a hazard
- recognize the consequence

SHOCK HAZARD

Labels may be located on or inside the equipment (e.g., drive or motor) to alert people that dangerous voltage may be present.

BURN HAZARD

Labels may be located on or inside the equipment (e.g., drive or motor) to alert people that surfaces may be dangerous temperatures.

Introduction

This release of this document contains new and updated information. To find new and updated information, look for change bars, as shown next to this paragraph.

Updated Information

This document contains the following changes:

Change	Page
Quick start for setting up motion control	2-1
Make sure that your Kinetix 6000 drive has firmware revision 1.80 or later if you want to use its auxiliary feedback port.	6-12, 10-10
Troubleshoot situations that are associated with S-Curve profiles	15-1
Inhibit an axis	16-1

Notes:

The Purpose of This Manual

Use this manual to setup and program motion control using a Logix5000™ motion module.

Related Documentation

	To:	See:
	get started with a Logix5000 controller	*Logix5000 Controllers Quick Start*, publication 1756-QS001
	use a ControlLogix® controller	*ControlLogix System User Manual*, publication 1756-UM001
	program a Logix5000 controller—detailed and comprehensive information	*Logix5000 Controllers Common Procedures*, publication 1756-PM001
You are here	set up and program motion control	*Logix5000 Motion Modules User Manaul*, publication 1756-UM006
	program a specific instruction	• *Logix5000 Controllers General Instructions Reference Manual*, publication 1756-RM003 • *Logix5000 Controllers Process and Drives Instructions Reference Manual*, publication 1756-RM006 • *Logix5000 Controllers Motion Instructions Reference Manual*, publication 1756-RM007
	• use equipment phases • set up a state model for your equipment • program in a way that is similar to S88 and PackML models	*PhaseManager User Manual*, publication LOGIX-UM001
	EtherNet/IP network—control devices	*EtherNet/IP Modules in Logix5000 Control Systems User Manual*, publication ENET-UM001
	ControlNet™ network—control devices	*ControlNet Modules in Logix5000 Control Systems User Manual*, publication CNET-UM001
	DeviceNet™ network—control devices	*DeviceNet Modules in Logix5000 Control Systems User Manual*, publication DNET-UM004
	import or export a Logix5000 project or tags from or to a text file	*Logix5000 Controllers Import/Export Reference Manual*, publication 1756-RM084
	convert a PLC-5 or SLC 500 application to a Logix5000 project	*Logix5550 Controller Converting PLC-5 or SLC 500 Logic to Logix5550 Logic Reference Manual*, publication 1756-6.8.5
	1756-M02AE module—install, wire, and troubleshoot	*Analog Encoder (AE) Servo Module Installation Instructions*, publication 1756-IN047
	1756-M03SE module—install, wire, and troubleshoot	*ControlLogix SERCOS interface Module Installation Instructions*, publication 1756-IN572G-EN-P
	1756-M08SE module—install, wire, and troubleshoot	
	1756-M16SE module—install, wire, and troubleshoot	
	1394C-SJTxx-D drive—install, wire, and set up	*1394 SERCOS Interface Multi Axis Motion Control System*, publication 1394C-5.20

To:	See:
1394 drive with SERCOS—start up and troubleshoot	*1394 SERCOS Integration Manual,* publication 1394-IN024
Ultra3000 drive—install	*Ultra3000 Hardware Installation Manual*, publication 2098-IN003
Ultra3000 drive with SERCOS—start up and troubleshoot	*Ultra3000 SERCOS Integration Manual*, publication 2098-IN005
Kinetix 6000 drive—design, install, and wire	*Kinetix 6000 Installation Manual*, publication 2094-IN001
Kinetix 6000 drive with SERCOS—start up and troubleshoot	*Kinetix 6000 Integration Manual*, publication 2094-IN002
8720MC High Performance drive—use	*8720MC High Performance Drive User Manual*, publication 8720MC-UM001

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The ControlLogix Motion Control System

This chapter describes the ControlLogix motion control system.

ControlLogix Motion Control

The ControlLogix controller, 1756-M02AE servo module, 1756-M03SE, 1756-M08SE, and 1756-M16SE SERCOS interface modules, and RSLogix 5000 programming software provide integrated motion control support.

- The ControlLogix controller contains a high-speed motion task, which executes ladder motion commands and generates position and velocity profile information. The controller sends this profile information to one or more 1756-M02AE servo modules or 1756-M*xx*SE SERCOS interface modules. You can use several Logix controllers in each chassis. Each controller can control up to 32 axes of motion.

- The 1756-L60M03SE is a combination of two existing modules, physically connected together to form a double wide ControlLogix module. It is comprised of the 1756-L63 controller and a 1756-M03SE motion module. This product is targeted to users that have a 3 axis or less SERCOS interface application.

- The 1756-M02AE servo module connects to a servo drive and closes a high-speed position and velocity loop. Each Logix controller can support up to 16 1756-M02AE servo modules. Each 1756-M02AE module can control up to two axes.

- The 1756-HYD02 is modeled along the lines of the 1756-M02AE with emphasis on hydraulic applications. It supports two axes and the AXIS_SERVO data type.

- The 1756-M02AS is a two channel Synchronous Serial Interface (SSI) module that implements a complete two axis digital position servo system using absolute transducers with SSI feedback.

- The 1756-M03SE SERCOS interface module serves as the interface between one ControlLogix processor and 1 to 3 axes operating in either position or velocity mode. The module has a programmable ring Cycle Period of 0.5 ms, 1 ms, or 2 ms depending on the number of axes and a ring Data Rate of 4 or 8 Mbaud.

- The 1756-M08SE SERCOS interface module serves as the interface between one ControlLogix processor and 1 to 8 axes operating in either position or velocity mode. The module has a programmable ring Cycle Period of 0.5 ms, 1 ms, or 2 ms depending on the number of axes and a ring Data Rate of 4 or 8 Mbaud.

- The 1756-M16SE SERCOS interface module serves as the interface between one ControlLogix processor and 1 to 16 axes operating in either position or velocity mode. The module has a programmable ring Cycle Period of 0.5 ms, 1 ms, or 2 ms depending on the number of axes and a ring Data Rate of 4 or 8 Mbaud.

- RSLogix 5000 programming software provides complete axis configuration and motion programming support.

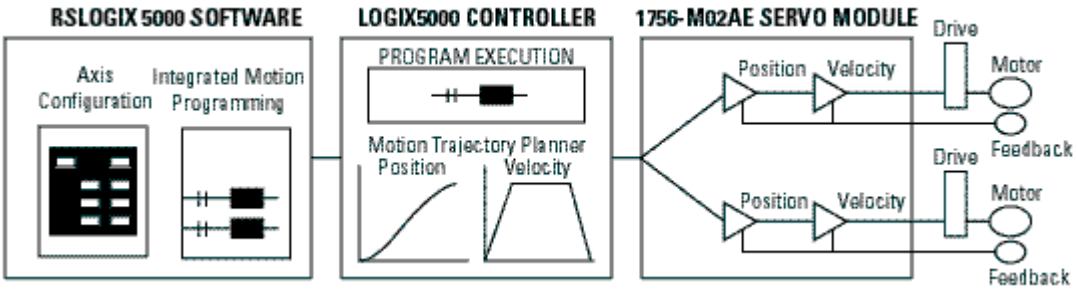


Figure 1.1 ControlLogix System with 1756-M02AE

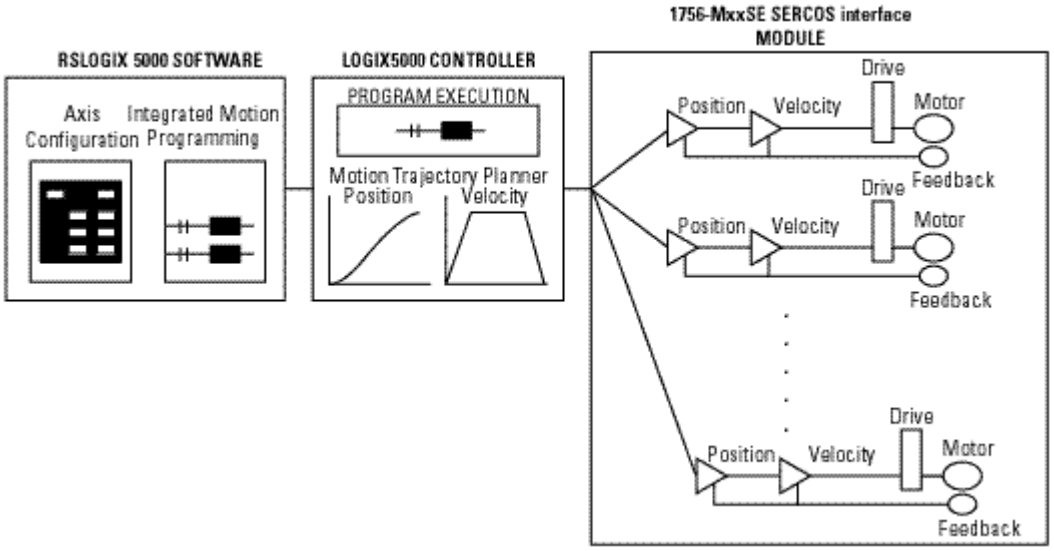


Figure 1.2 ControlLogix System with 1756-MxxSE

Components of the ControlLogix Motion System

The ControlLogix Controller

The ControlLogix controller is the main component in the ControlLogix system. It supports sequential and motion functions, and it performs all of the motion command execution and motion trajectory planner functions. You can use one or more ControlLogix controllers in each chassis, and each controller can control up to 32 axes of motion.

The ControlLogix controller provides the following motion support:

- Thirty eight motion instructions
- A high-speed motion task, which manages motion functions and generates move profiles
- The ability to control up to 16 Analog/Encoder servo modules for a total of 32 axes
- SERCOS support

The Combo Module (1756-L60M03SE)

The Combo module is comprised of the 1756-L63A controller and the 1756-M03SE SERCOS interface motion module. The two modules are physically connected to each other to form a double wide ControlLogix module with two lenses and one door.

The hardware has the same properties as its two inclusive modules with these exceptions:

- User RAM is limited to 750Kbytes.
- It has 8Mbytes of Flash memory.

The Analog/Encoder Servo Module (1756-M02AE)

The Analog/Encoder servo module provides an analog/quadrature encoder servo drive interface. The servo module receives configuration and move information from the ControlLogix controller and manages motor position and velocity.

The servo module supports:

- Connection capability for up to two drives
- ±10V analog outputs
- Quadrature encoder inputs
- Home limit switch inputs
- Drive fault inputs
- Drive enable outputs
- 5V or 24V position registration inputs
- 250 µs position and velocity loop updates

The Hydraulic Module (1756-HYD02)

The Hydraulic Module implements a complete two axis digital position servo system using Linear Magnetostrictive Displacement Transducer (LDT) inputs providing analog servo output to external and proportional valves.

The Hydraulic module supports many of the same features as the 1756-M02AE with these exceptions:

- Feed Forward adjust is supported in addition to single-step Auto Tune.
- Gain ratio between extend direction and retract direction to accommodate hydraulic cylinder dynamics.
- Intelligent transducer noise detection filtering in hardware and firmware replaces programmable IIR filtering.
- No encoder feedback.
- LDT interface consisting of Differential Interrogate and Return signals replaces the differential encoder interface.
- Position feedback update rate is variable (0.5, 1, and 2 milliseconds).
- A dead-band eliminator algorithm compensates for proportional valves with overlap.

The Synchronous Serial Interface (SSI) Module (1756-M02AS)

The ControlLogix SSI module implements a complete two axis digital position servo system using absolute transducers with Synchronous Serial Interface (SSI) feedback.

The SSI module supports many of the same features as the 1756-M02AE with these exceptions:

- Feed Forward adjust is supported in addition to single-step Auto Tune.
- Gain ratio between extend direction and retract direction to accommodate hydraulic cylinder dynamics.
- Intelligent transducer noise detection filtering in hardware and firmware replaces programmable IIR filtering.

- No encoder feedback.
- SSI interface consisting of Differential Clock output and Data return signals replaces the differential encoder interface.
- Position feedback update rate is variable (0.2, 0.5, 1, and 2 milliseconds).
- A dead-band eliminator algorithm compensates for proportional valves with overlap.

The 3, 8, or 16 Axis SERCOS interface Module (1756-M08SE, 1756-M16SE)

The 3, 8, or 16 Axis SERCOS interface modules (1756-M03SE, 1756-M08SE, 1756-M16SE) serves as a link between the ControlLogix platform and intelligent drives. The communication link between the module and the drive(s) is via IEC 1491 **SE**rial **R**eal-time **CO**mmunication **S**ystem (SERCOS) using fiber optic medium.

The SERCOS interface module supports:

- reliable high speed data transmission
- excellent noise immunity
- elimination of interconnect wiring
- ASA messages converted to SERCOS formatted messages

RSLogix 5000 Programming Software

The RSLogix 5000 programming software provides complete programming and commissioning support for the ControlLogix system. RSLogix 5000 is the only programming software needed to fully configure and program ControlLogix motion control systems.

RSLogix 5000 software provides the following motion support:

- Wizards for servo axis configuration including drive hookup diagnostics and auto tuning
- Ladder-based application programming including support for 31 motion commands

Developing a Motion Control Application Program

This section provides an introduction to concepts used in developing application programs for motion control. These concepts include:

- Application program development
- The MOTION_INSTRUCTION tag
- Motion status and configuration parameters
- Modifying motion configuration parameters
- Handling motion faults

Application Program Development

Developing a motion control application program involves the following:

Task	Description
Select the master coordinated system time	Sets one controller as the master controller. Once you complete this step, you can synchronize all the motion modules and ControlLogix controllers in your chassis
Name and Configure an axis	Adds an axis to your application program
Develop a motion application program	Create a program for your motion control application
Add a motion module	Adds a motion module to your application program
Assign additional servo modules and axes	Adds additional modules and axes to your application program
Run hookup diagnostics and auto tuning	Completes hookup diagnostics and auto tuning for each axis

The MOTION_INSTRUCTION Tag

The controller uses the MOTION_INSTRUCTION tag (structure) to store status information during the execution of motion instructions. Every motion instruction has a motion control parameter that requires a MOTION_INSTRUCTION tag to store status information.

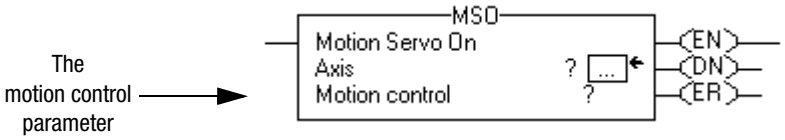


Figure 1.3 Motion Control Parameter

ATTENTION

Tags used for the motion control parameter of instructions should only be used once. Re-use of the motion control parameter in other instructions can cause unintended operation of the control variables.

For more information about the MOTION_INSTRUCTION tag, refer to Appendix C - *The Motion Control Structures* and the *Logix Controller Motion Instruction Set Reference Manual* (1756-RM007).

Motion Status and Configuration Parameters

You can read motion status and configuration parameters in your ladder logic program using two methods.

Method	Example	For more information
Directly accessing the AXIS and MOTION_GROUP structures	• Axis faults • Motion status • Servo status	Refer to Appendix C - *The Motion Control Structures*
Using the GSV instruction	• Actual position • Command position • Actual velocity	Refer to the *Input/Output Instructions* chapter of the *Logix Controller Instruction Set Reference Manual*, publication 1756-RM003B

Modifying Motion Configuration Parameters

In your ladder logic program, you can modify motion configuration parameters using the SSV instruction. For example, you can change position loop gain, velocity loop gain, and current limits within your program.

For more information about the SSV instruction, refer to the Logix Controller Instruction Set Reference Manual, publication 1756-RM003.

Handling Motion Faults

Two types of motion faults exist.

Type	Description	Example
Motion Instruction Errors	• Do not impact controller operation • Should be corrected to optimize execution time and ensure program accuracy	A Motion Axis Move (MAM) instruction with a parameter out of range
Minor/Major Faults	• Caused by a problem with the servo loop • Can shutdown the controller if you do not correct the fault condition	The application exceeded the PositionErrorTolerance value

For more information about handling faults, see *Handling Controller Faults* in the *Logix Controller User Manual*, publication 1756-UM001 and *Appendix F Fault Handling* in this manual.

Quick Start

Use This Chapter

Use this chapter as an overview of how to set up and program motion control. If you aren't using SERCOS interface drives and modules, skip actions 3 and 4.

Action	See page
1. Make the Controller the CST Master	2-2
2. Add the Motion Modules	2-3
3. Add SERCOS interface Drives	2-4
4. Set Up Each SERCOS Interface Module	2-5
5. Add the Motion Group	2-6
6. Add Your Axes	2-8
7. Set Up Each Axis	2-9
8. Check the Wiring of Each Drive	2-12
9. Tune Each Axis	2-13
10. Program Motion Control	2-14
11. Additional Actions	2-16

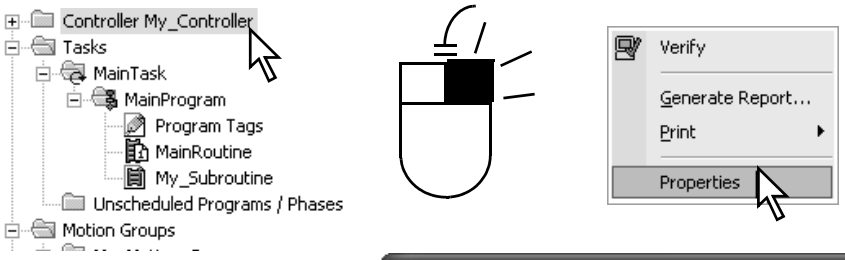
Make the Controller the CST Master

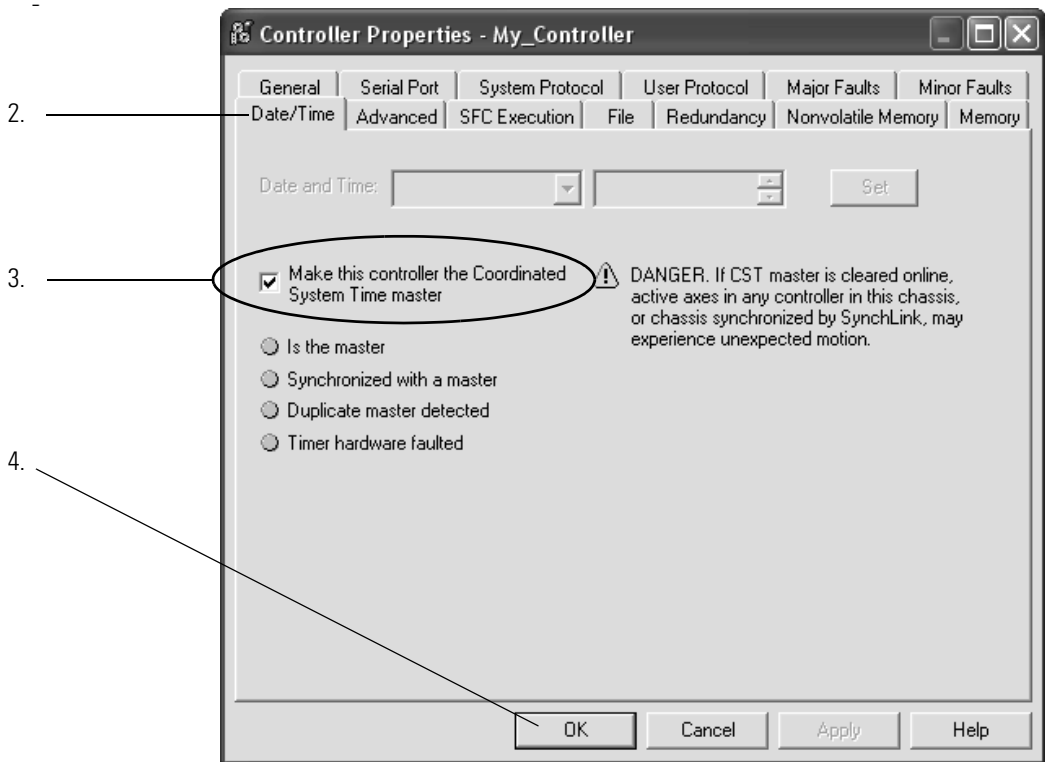
You must make one module in the chassis the master clock for motion control. This module is called the coordinated system time (CST) master.

coordinated system time (CST) master	The master clock for motion control for a chassis. The motion modules set their clocks to the master.

In most cases, make the controller the CST master.

1.





If you have more than 1 controller in the chassis

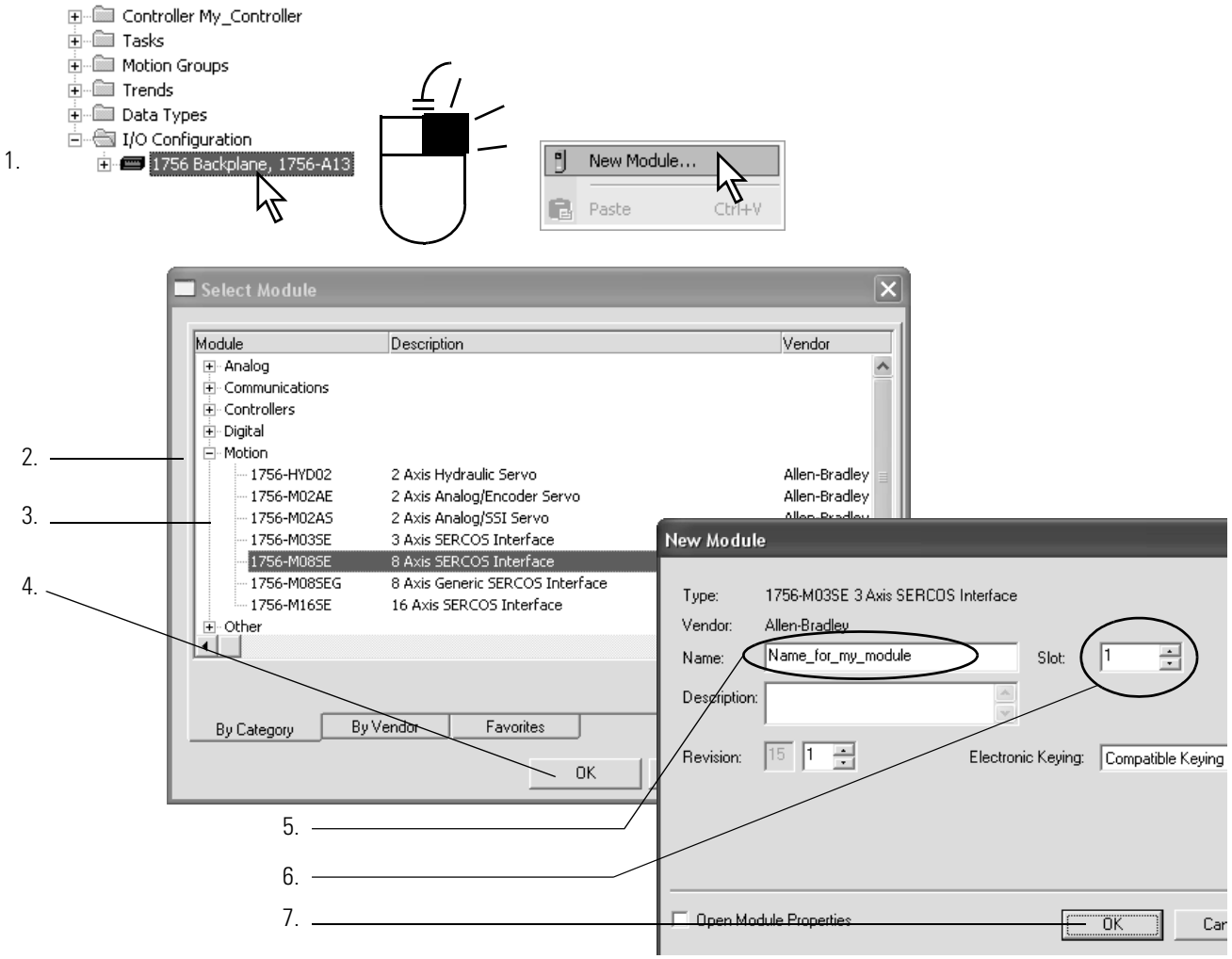
If you have more than 1 controller in the chassis, choose 1 of the controllers to be the CST master. You can't have more than one CST master for the chassis.

Add the Motion Modules

Use up to 16 motion modules with your ControlLogix controller:

IMPORTANT For your motion modules, use the firmware revision that goes with the firmware revision of your controller. See the release notes for your controller's firmware.

SERCOS interface?	Use this motion module	
Yes	3 axes	1756-M03SE
	3 axes plus controller	1756-L60M03SE
	8 axes	1756-M08SE
	16 axes	1756-M16SE
No	quadrature feedback	1756-M02AE
	LDT feedback	1756-HYD02
	SSI feedback	1756-M02AS



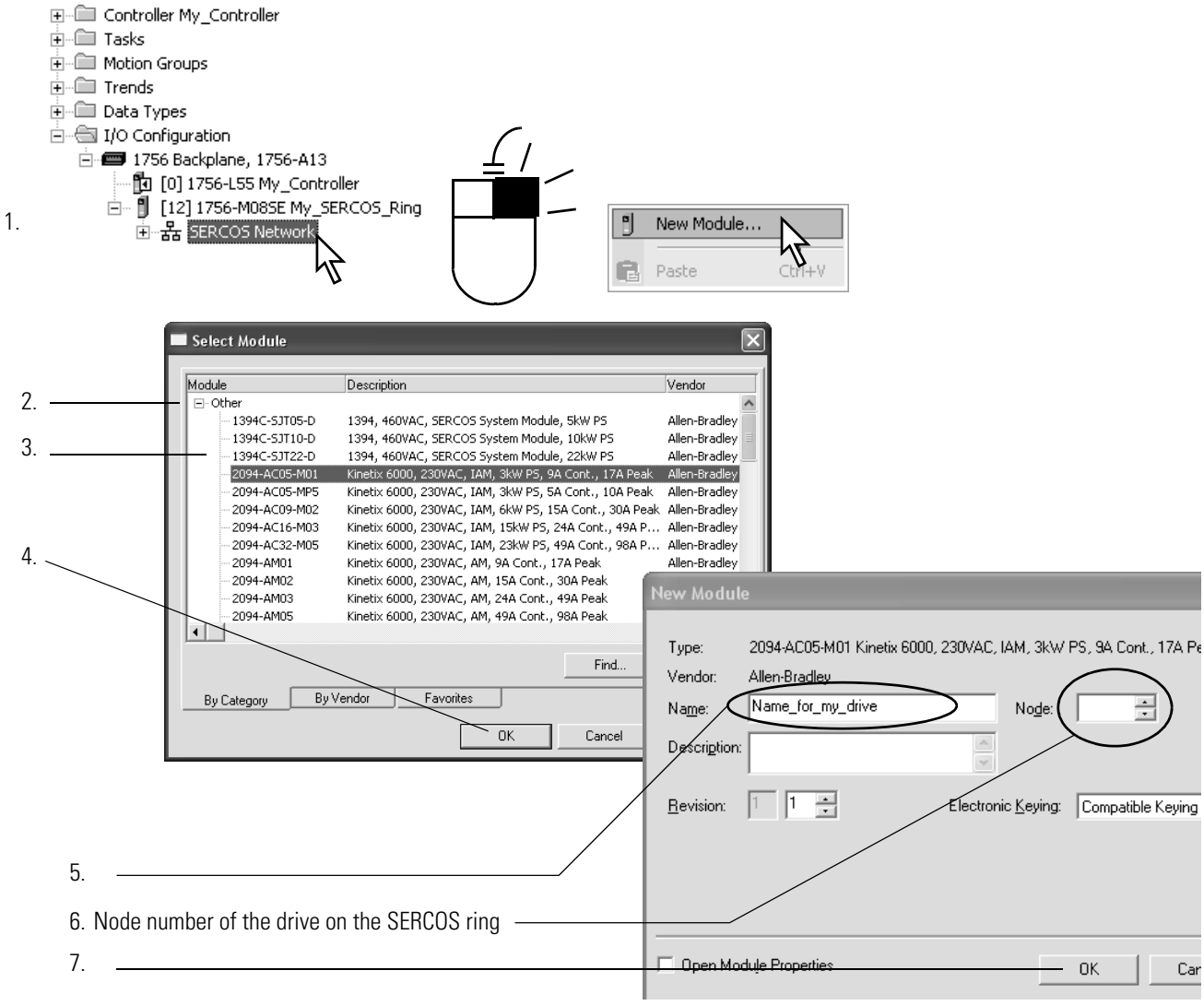
Add SERCOS interface Drives

See:
- *Motion Analyzer*, PST-SG003
- *ControlLogix Selection Guide*, 1756-SG001

Choose from these SERCOS interface drives:

- 1394
- Kinetix 6000
- Ultra3000
- 8720MC

Add SERCOS interface drives to the I/O configuration of the controller. This lets you use RSLogix 5000 software to set up the drives.


1.
Controller My_Controller
Tasks
Motion Groups
Trends
Data Types
I/O Configuration
1756 Backplane, 1756-A13
[0] 1756-L55 My_Controller
[12] 1756-M08SE My_SERCOS_Ring
SERCOS Network
New Module...
Paste Ctrl+V
Select Module
Module
Description
Vendor
Other
1394C-SJT05-D 1394, 460VAC, SERCOS System Module, 5kW PS Allen-Bradley
1394C-SJT10-D 1394, 460VAC, SERCOS System Module, 10kW PS Allen-Bradley
1394C-SJT22-D 1394, 460VAC, SERCOS System Module, 22kW PS Allen-Bradley
2094-AC05-M01 Kinetix 6000, 230VAC, IAM, 3kW PS, 9A Cont., 17A Peak Allen-Bradley
2094-AC05-MP5 Kinetix 6000, 230VAC, IAM, 3kW PS, 5A Cont., 10A Peak Allen-Bradley
2094-AC09-M02 Kinetix 6000, 230VAC, IAM, 6kW PS, 15A Cont., 30A Peak Allen-Bradley
2094-AC16-M03 Kinetix 6000, 230VAC, IAM, 15kW PS, 24A Cont., 49A P... Allen-Bradley
2094-AC32-M05 Kinetix 6000, 230VAC, IAM, 23kW PS, 49A Cont., 98A P... Allen-Bradley
2094-AM01 Kinetix 6000, 230VAC, AM, 9A Cont., 17A Peak Allen-Bradley
2094-AM02 Kinetix 6000, 230VAC, AM, 15A Cont., 30A Peak
2094-AM03 Kinetix 6000, 230VAC, AM, 24A Cont., 49A Peak
2094-AM05 Kinetix 6000, 230VAC, AM, 49A Cont., 98A Peak
Find...
By Category
By Vendor
Favorites
OK
Cancel
2.
3.
4.
New Module
Type: 2094-AC05-M01 Kinetix 6000, 230VAC, IAM, 3kW PS, 9A Cont., 17A Pe
Vendor: Allen-Bradley
Name: Name_for_my_drive
Node:
Description:
Revision: 1 1
Electronic Keying: Compatible Keying
Open Module Properties
OK
5.
6. Node number of the drive on the SERCOS ring
7.

Set Up Each SERCOS Interface Module

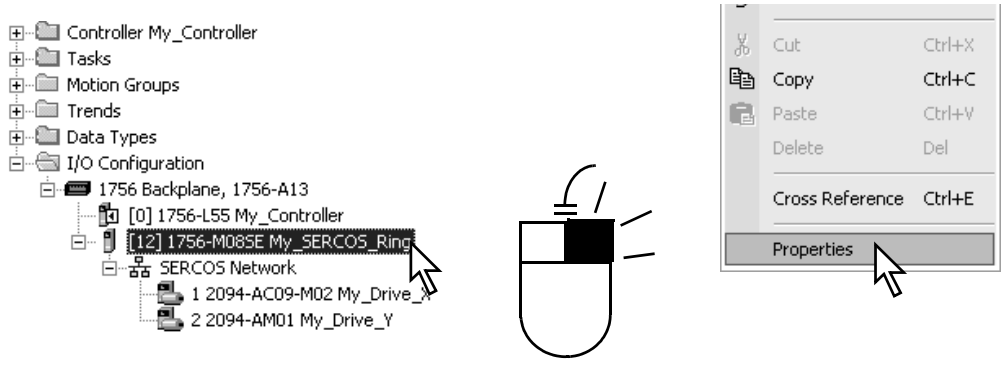
Set the data rate and cycle time for each SERCOS interface module in your project.

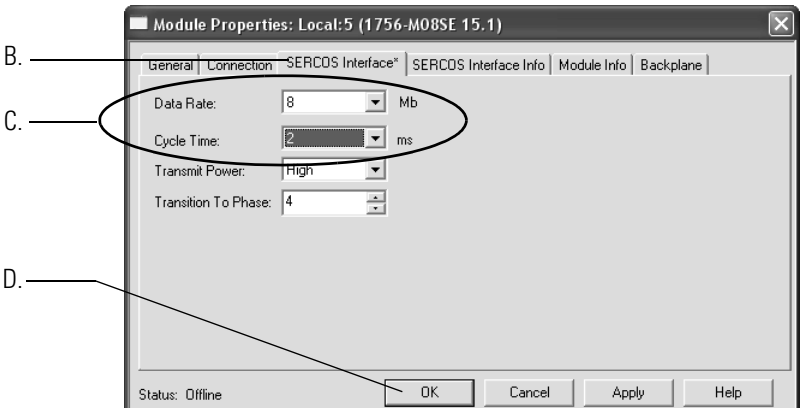
Action	Details
1. **Decide which data rate to use.**	Do your drives have a 8 Mb data rate (most do)? • YES — Use a 8 MB data rate. • NO — Use a 4 MB data rate.
2. **Decide which cycle time to use.**	Use the following table to decide the cycle time for your SERCOS interface module:

Data rate	Number of drives on the ring	Type of drives	Cycle time
4 Mb	1 or 2	Kinetix 6000	0.5 ms
		NOT Kinetix 6000	1 ms
	3 or 4	→	1 ms
	5…8	→	2 ms
	9…16	→	Can't do. You must have 2 motion modules.
8 Mb	1…4	Kinetix 6000	0.5 ms
		NOT Kinetix 6000	1 ms
	5…8	→	1 ms
	9…16	→	2 ms

3. **Set the data rate and cycle time.**

A.

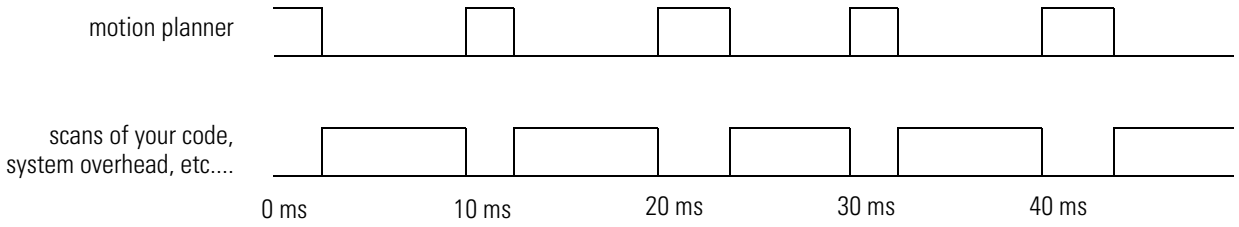




Add the Motion Group

Add a motion group to set up the motion planner.

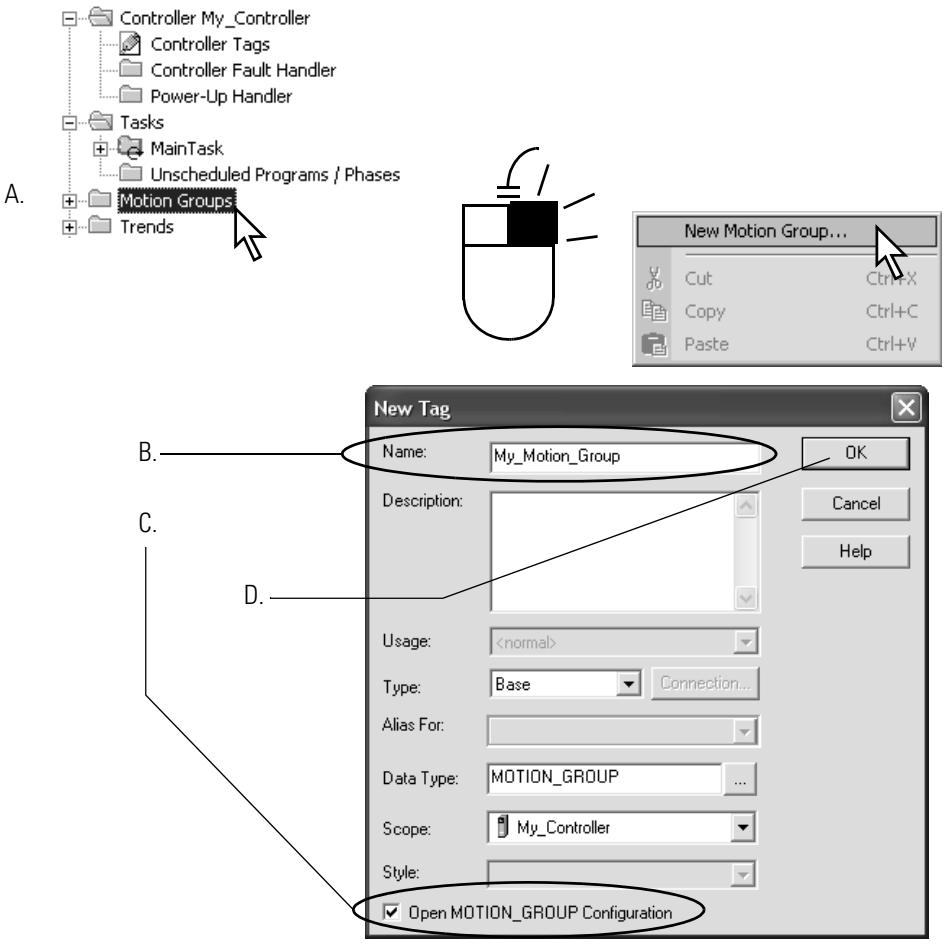
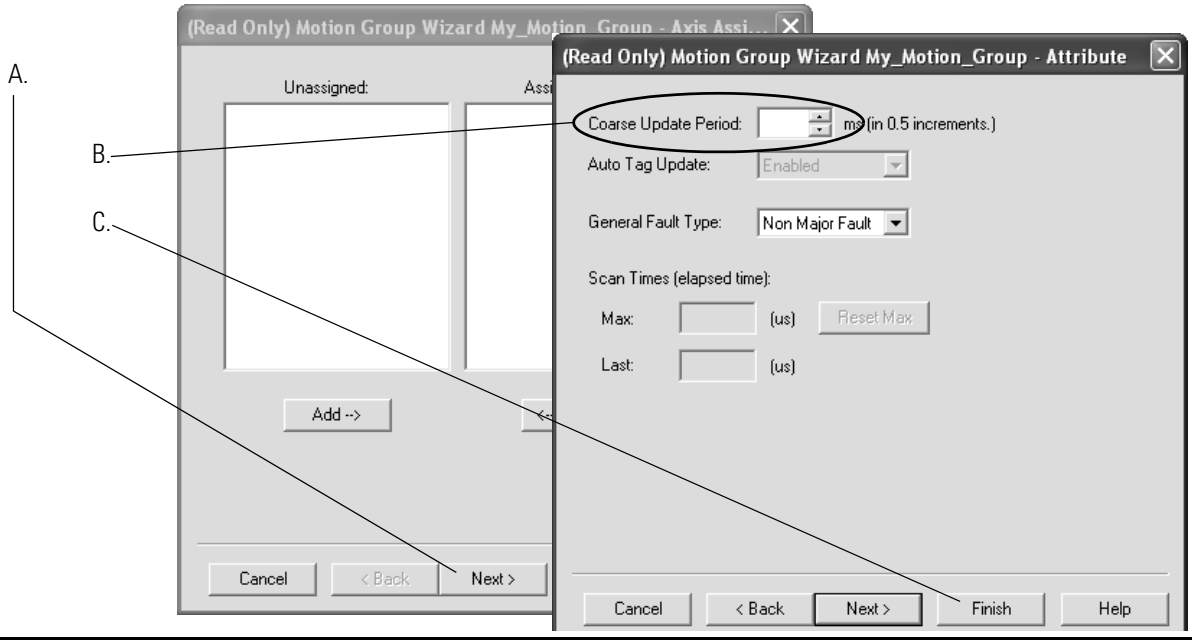
motion planner	Part of the controller that takes care of position and velocity information for your axes
coarse update period	How often the motion planner runs. When the motion planner runs, it interrupts all other tasks regardless of their priority.



In this example, the coarse update period = 10 ms. Every 10 ms the controller stops scanning your code and whatever else it is doing and runs the motion planner.

IMPORTANT Add only 1 motion group for the project. RSLogix 5000 software doesn't let you add more than 1 motion group.

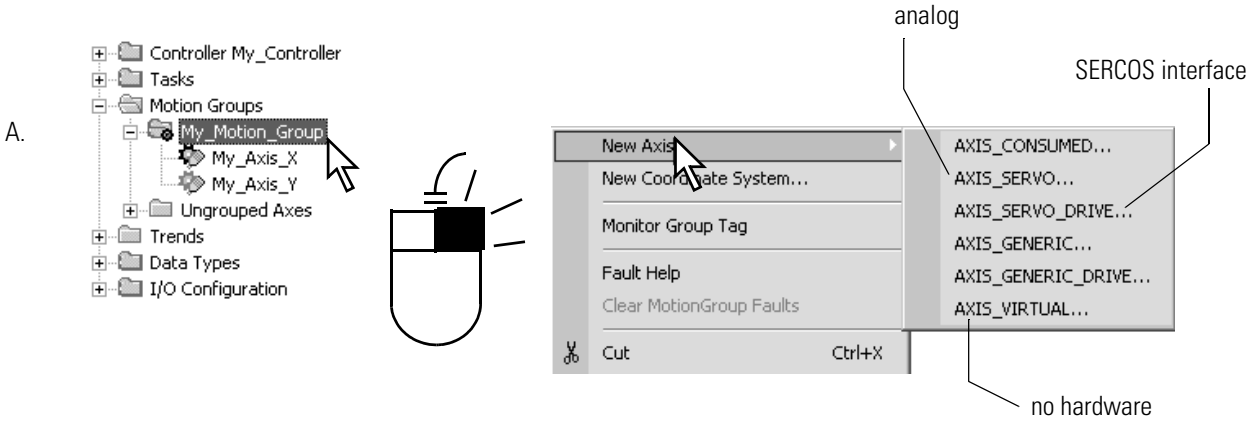
Action	Details
1. **Choose your coarse update period.**	The coarse update period is a trade-off between updating positions of your axes and scanning your code. Use these guidelines as a rough starting point. A. How many axes do you have? • Less than 11 axes — Set the coarse update period to 10 ms. • 11 axes or more — Set the coarse update period to 1 ms per axis. B. Leave at least half the controller's time for the scan of all your code. C. If you have SERCOS interface motion modules, set the coarse update period to a multiple of the cycle time of the motion module. Example: if the cycle time is 2 ms, set the coarse update period to 8 ms, 10 ms, 12 ms, etc. D. If you have analog motion modules, set the coarse update period to: 1. At least 3 times the servo update period of the motion module 2. A multiple of the servo update period of the motion module

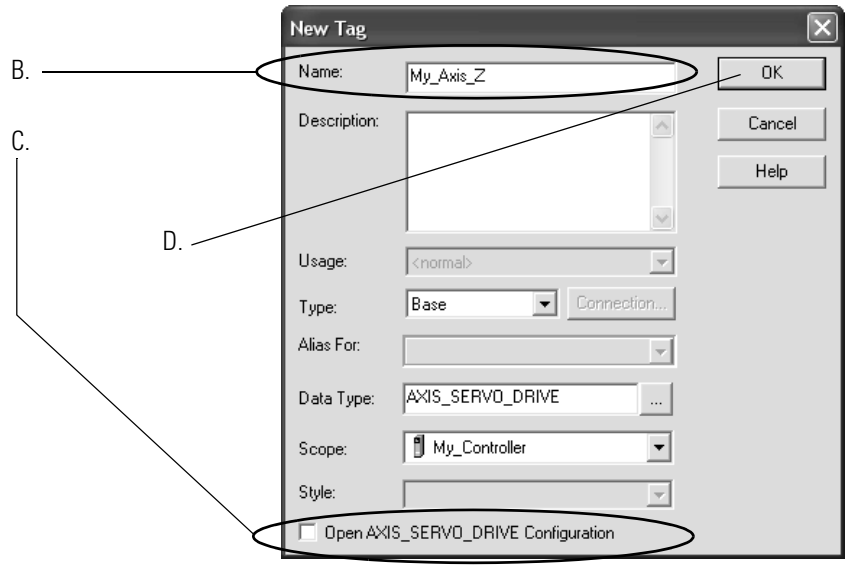
Action	Details
2. **Add the motion group.**	
3. **Set the coarse update period.**	

Add Your Axes

Add an axis for each of your drives.

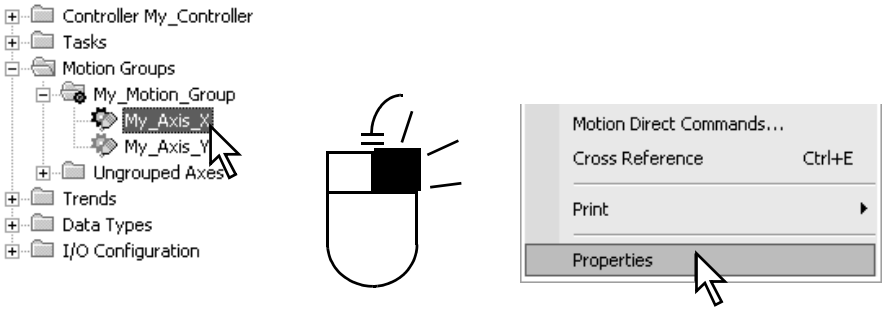
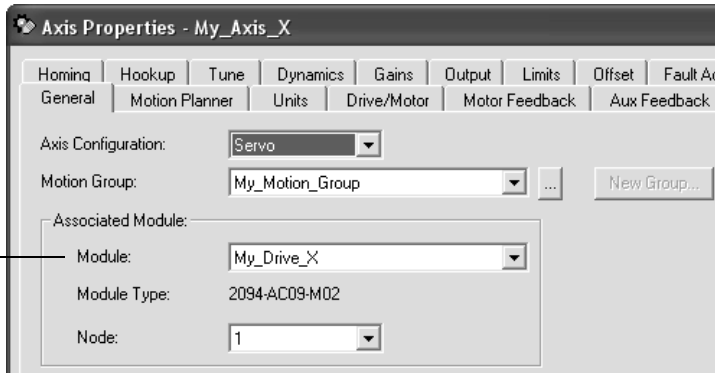
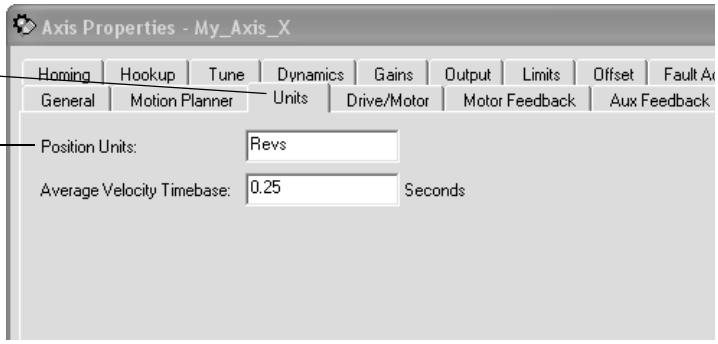
Action	Details	
1. **Decide which data type to use.**	**If you use this motion module for the axis**	**Then use this data type**
	1756-M03SE 1756-M08SE 1756-M16SE 1756-L60M03SE	AXIS_SERVO_DRIVE
	1756-M02AE 1756-HYD02 1756-M02AS	AXIS_SERVO
2. **Add an axis.**		





Set Up Each Axis

The following steps show how to set up the axis of a SERCOS interface drive. The steps are slightly different if you have a different type of drive.

Action	Details
1. **Open the properties for the axis.**	
2. **Select the drive for the axis.** Select the name that you gave to the drive for this axis.	
3. **Set the units that you want to program in.** A. B. Type the units that you want to use for programming, such as revs, degrees, inches, or millimeters.	

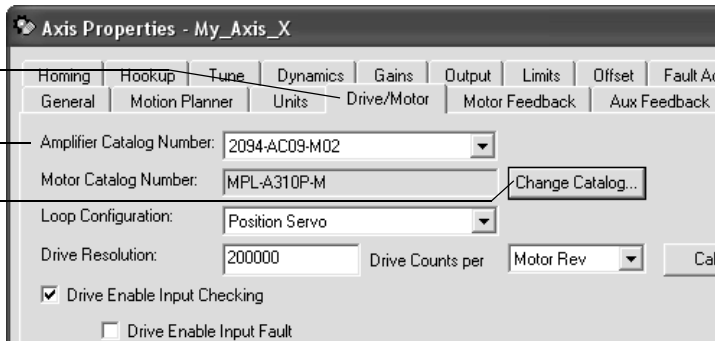
Action	Details

4. **Select the drive and motor catalog numbers.**

A.

B. Select the catalog number of the drive.

C. Select the catalog number of the motor.



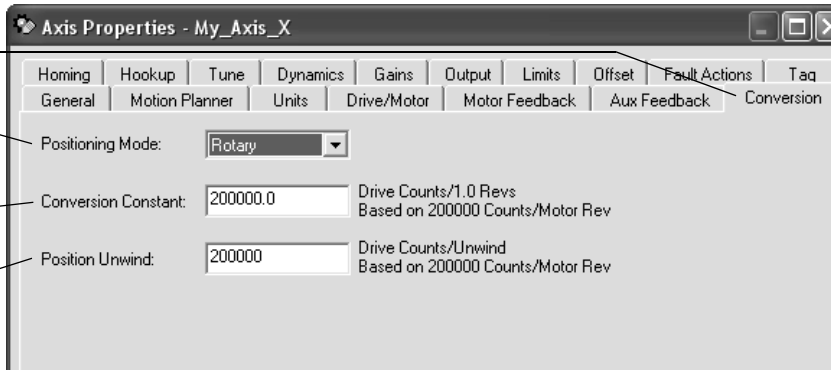
5. **Set the conversion between drive counts and units.**

A.

B. Select whether this is a rotary or linear axis.

C. Type the number of drive counts that equal one unit from Step 3B.

D. If this is a rotary axis, type the number of drive counts that you want to unwind after.

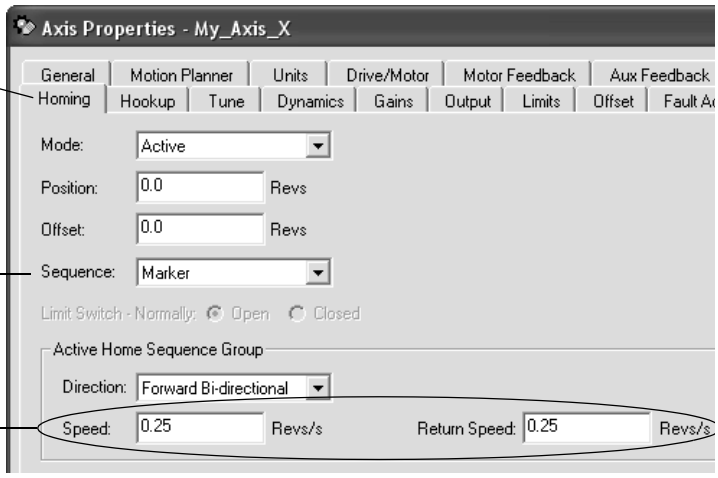


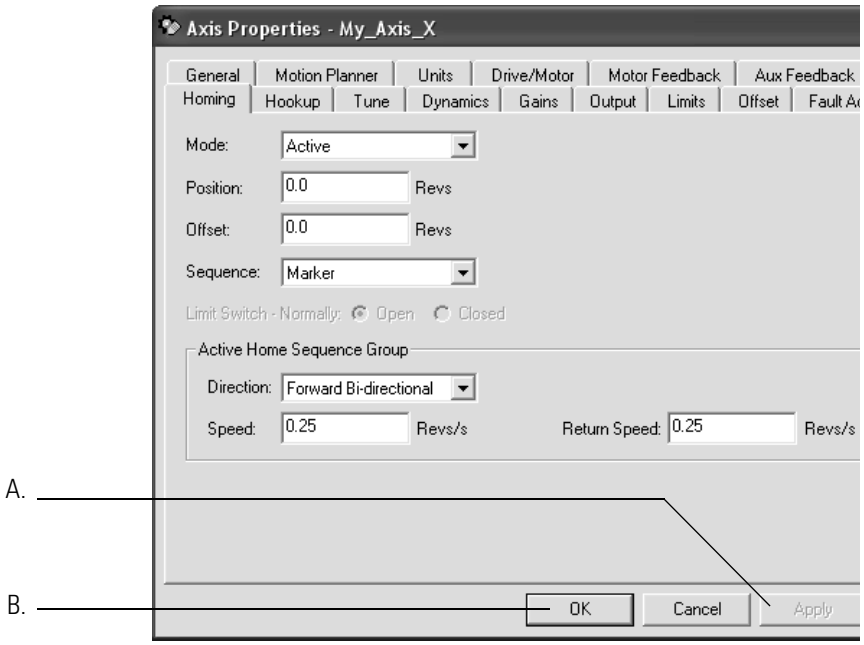
6. **Set up the homing sequence.**

A.

B. Select the type of homing sequence that you want.

C. Type homing speeds.



Action	Details
7. **Apply your changes.**	

Check the Wiring of Each Drive

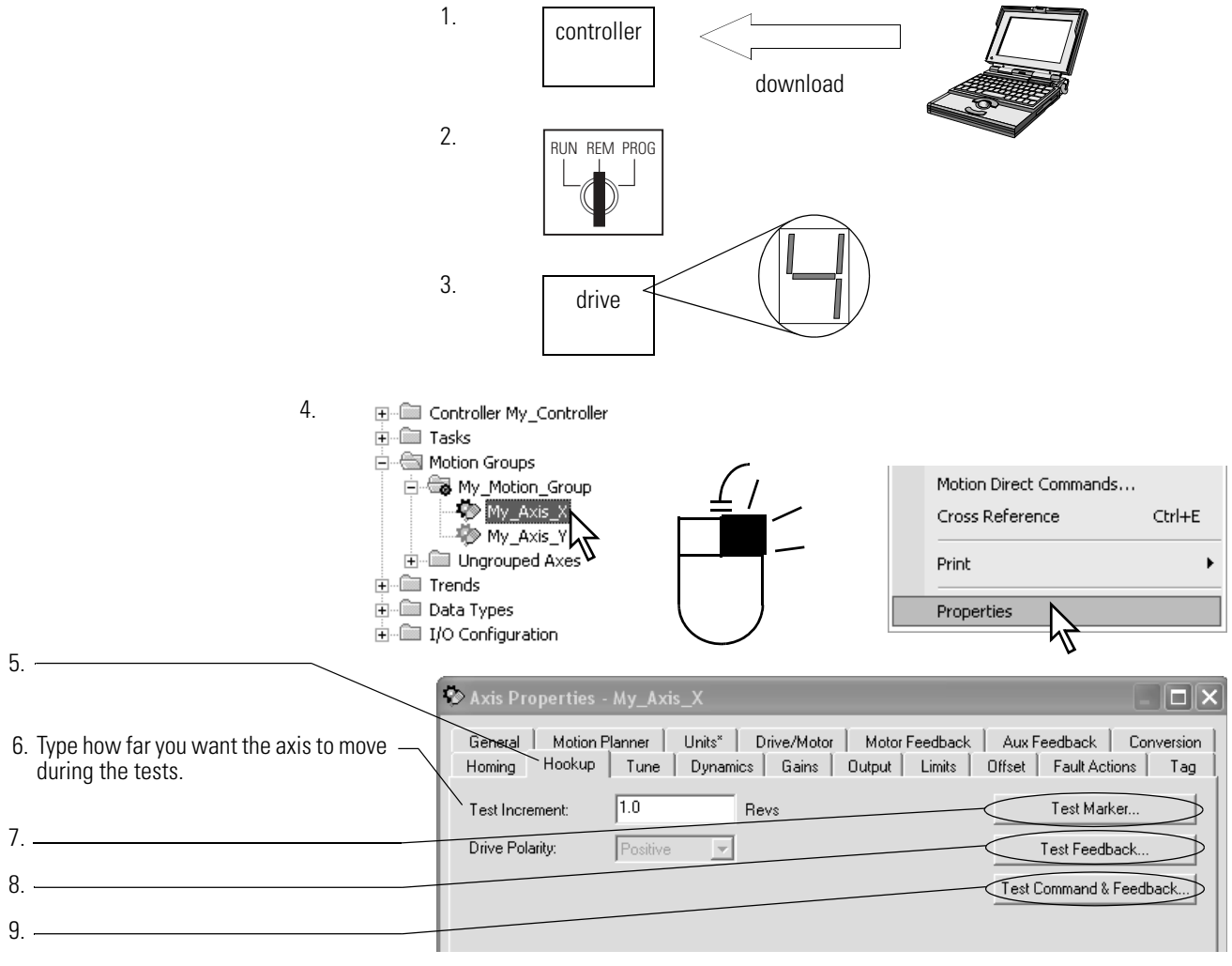
Use the hookup tests to check the wiring of a drive.

This test	Does this	Notes
Test marker	Checks that the drive gets the marker pulse.	You must manually move the axis for this test.
Test feedback	Checks the polarity of the feedback.	You must manually move the axis for this test.
Test command and feedback	Checks the polarity of the drive.	

ATTENTION

These tests make the axis move even with the controller in remote program mode.

- Before you do the tests, make sure no one is in the way of the axis.
- *Do not* change the polarity after you do the tests. Otherwise you may cause an axis-runaway condition.



Tune Each Axis

Use the Tune tab to tune an axis.

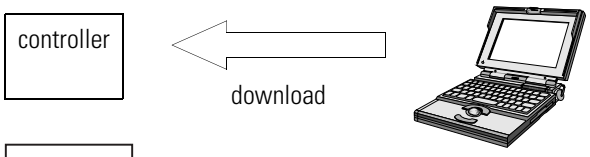
ATTENTION

When you tune an axis, it moves even with the controller in remote program mode. In that mode, your code is ***not*** in control of the axis.

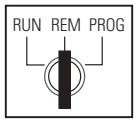
Before you tune an axis, make sure no one is in the way of the axis.

The default tuning procedure tunes the proportional gains. Typically, tune the proportional gains first and see how your equipment runs.

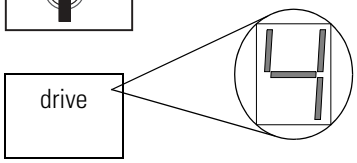
1.



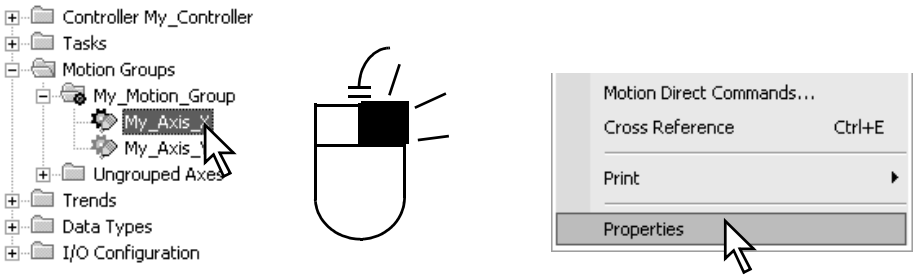
2.



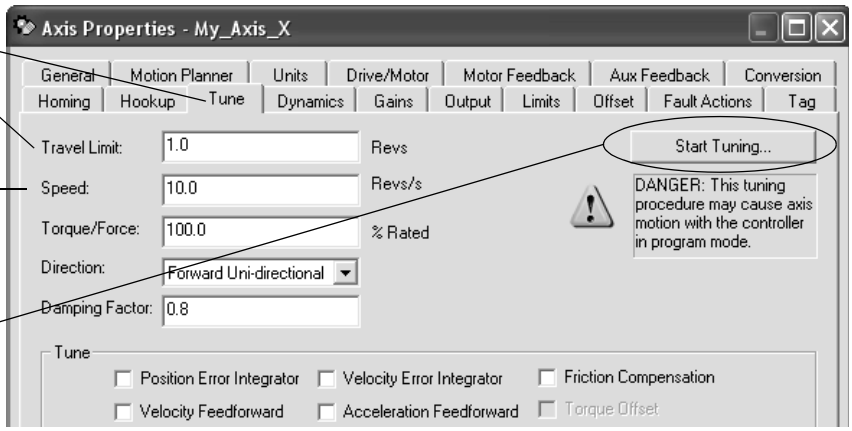
3.



4.



5. 6. Type the limit of movement for the axis during the tuning procedure. 7. Type the maximum speed for your equipment. 8.



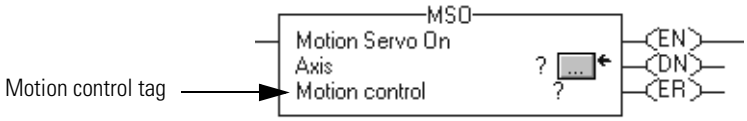
Program Motion Control

See:

- *Logix5000 Controllers Common Procedures Manual*, 1756-PM001
- *Logix5000 Controllers Motion Instructions Reference Manual*, 1756-RM007
- *Logix5000 Controllers General Instructions Reference Manual*, 1756-RM003

The controller gives you a set of motion control instructions for your axes.

- Uses these instructions just like the rest of the Logix5000 instructions. You can program motion control in these programming languages:
  - ladder diagram (LD)
  - structured text (ST)
  - sequential function chart (SFC)
- Each motion instruction works on one or more axes.
- Each motion instruction needs a motion control tag. The tag uses a MOTION_INSTRUCTION data type. The tag stores the status information of the instruction.



ATTENTION

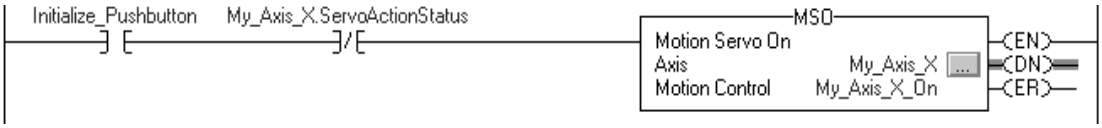
Use the tag for the motion control operand of motion instruction only once. Unintended operation of the control variables may happen if you re-use of the same motion control tag in other instructions.

Example

Here's an example of a simple ladder diagram that homes, jogs, and moves an axis.

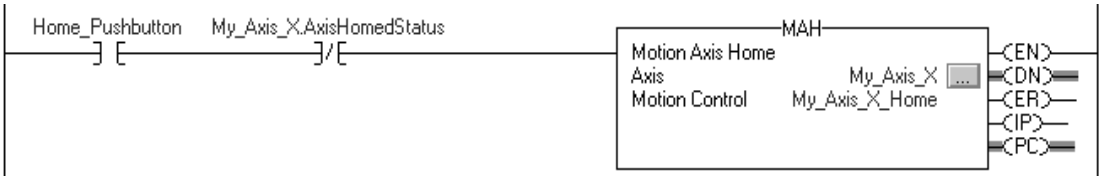
If *Initialize_Pushbutton* = on and the axis = off (*My_Axis_X.ServoActionStatus* = off) then

The MSO instruction turns on the axis.



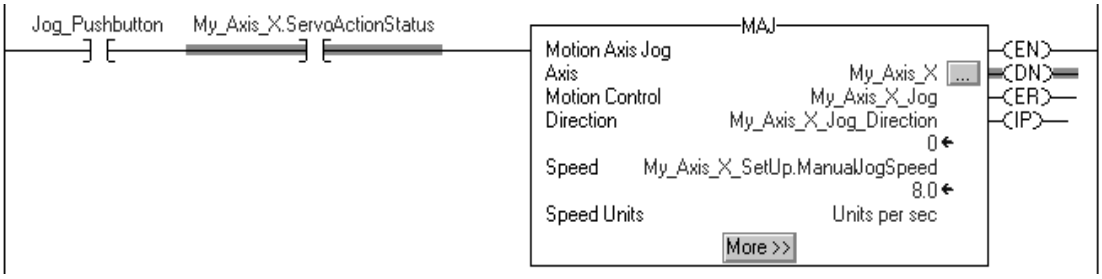
If *Home_Pushbutton* = on and the axis hasn't been homed (*My_Axis_X.AxisHomedStatus* = off) then

The MAH instruction homes the axis.



If *Jog_Pushbutton* = on and the axis = on (*My_Axis_X.ServoActionStatus* = on) then

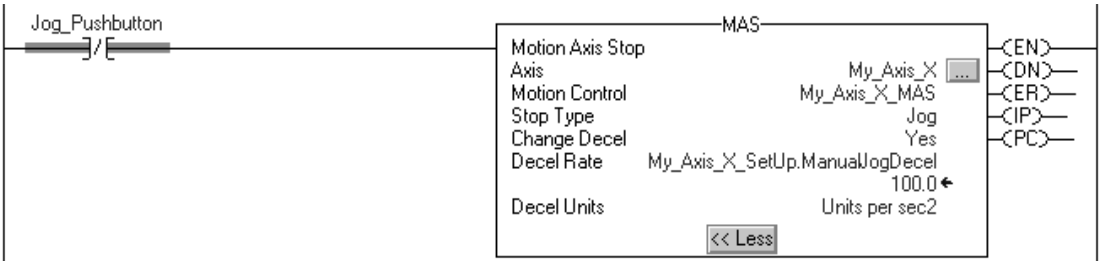
The MAJ instruction jogs the axis forward at 8 units/s.



If *Jog_Pushbutton* = off then

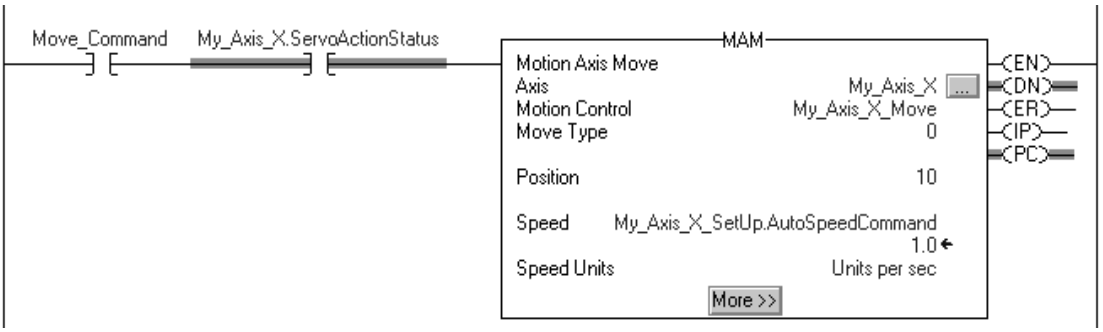
The MAS instruction stops the axis at 100 units/s^2

Make sure that *Change Decel* is *Yes*. Otherwise, the axis decelerates at its maximum speed.



If *Move_Command* = on and the axis = on (*My_Axis_X.ServoActionStatus* = on) then

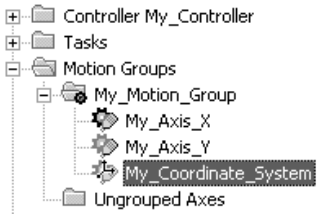
The MAM instruction moves the axis. The axis moves to the position of 10 units at 1 unit/s.

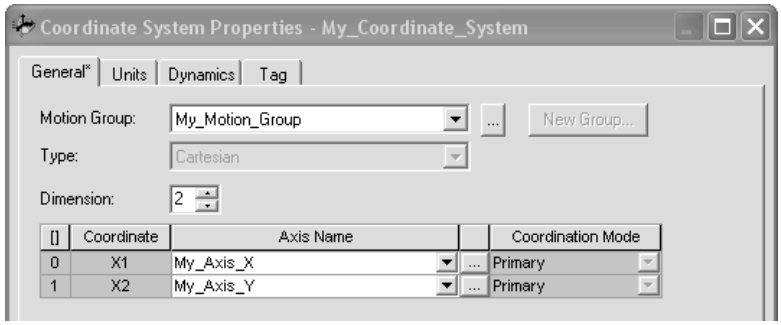


Additional Actions

The following actions are optional and depend on your situation.

Action	Details
Set up a coordinate system	A coordinate system lets you interpolate circular or linear moves using coordinate points. Set up the coordinate in either 1, 2, or 3 dimensions.





Get status information

Use these methods to read motion status and configuration parameters in your code.

Method:	Example:
Read the MOTION_GROUP and AXIS tags	• Axis faults • Actual position of an axis • Motion status
Use a Get System Value (GSV) instruction	Actual position

Change configuration parameters

Use a Set System Value (SSV) instruction to write code that changes motion parameters. For example, you can change position loop gain, velocity loop gain, and current limits within your code.

Handle motion faults

The controller has these types of motion faults:

Type	Description	Example
Instruction error	Caused by a motion instruction: • Instruction errors do not impact controller operation. • Look at the error code in the motion control tag to see why an instruction has an error. • Fix instruction errors to optimize execution time and make sure that your code is accurate	A Motion Axis Move (MAM) instruction with a parameter out of range
Fault	Caused by a problem with the servo loop: • You choose whether or not motion faults give the controller major faults. • Can shutdown the controller if you do not correct the fault condition	• Loss of feedback • Actual position exceeding an overtravel limit

Adding and Configuring Your 1756-M02AE, 1756-M02AS, 1756-HYD02 Motion Module

This chapter describes how to add, configure, and edit your 1756-M02AE, 1756-M02AS, and 1756-HYD02 motion modules for use in your motion control application. Many of the steps are identical regardless of the module you are adding to the control system.

Adding the 1756-M02AE, 1756-HYD02, or 1756-M02AS Module

To use your motion module in a control system, you must add your motion module to the application program. To add a motion module:

1. Right-click the I/O Configuration folder.

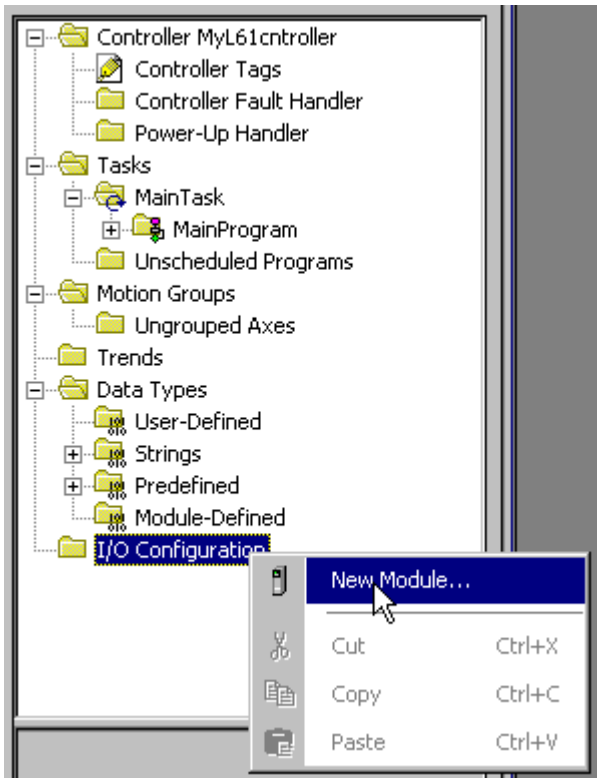


Figure 3.1 Selecting New Module from the Controller Organizer

2. Select **New Module**. The Select Module Type window appears.

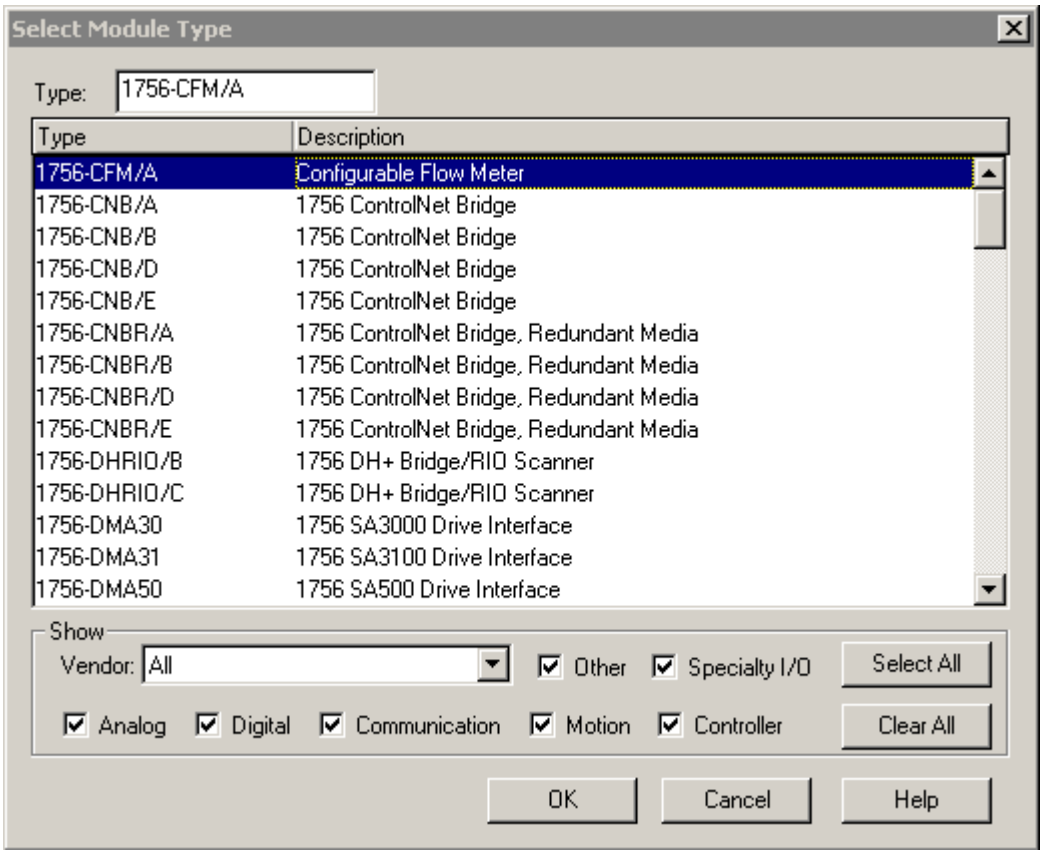


Figure 3.2 Select Module Type Screen Fully Loaded

3. Click on the Clear All button to clear the dialog window then click on Motion to list the available Motion Modules.

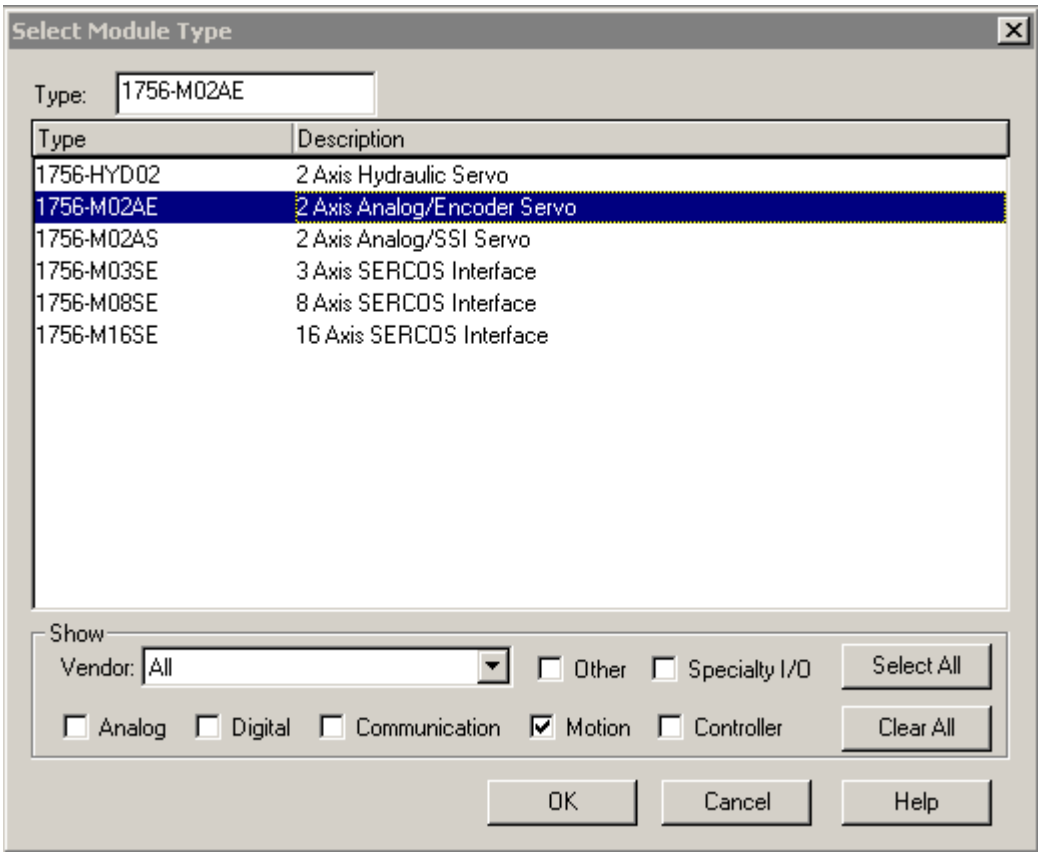


Figure 3.3 Select Module Type Screen with Motion Options - M02AE Highlighted

New Module

Use this dialog to select and create a new module. The context sensitive menu appears, from which you can select the module for your application.

Type

The Type field displays the catalog number of the module highlighted in the Type list box. You can either type in a module catalog number in this field to quickly select/find the module you want to create or you can scroll through the list of modules in the Type list box.

Type (list box)

This box lists the installed module catalog numbers based on the selected check boxes.

Description (list box)

This portion of the list box contains descriptions of the modules.

Show

Displays check boxes, which support filtering on particular types of modules.

Check this box:	If you want to:
Digital	display digital modules supported by the software
Analog	display analog modules supported by the software
Communication	display communication modules supported by the software
Motion	display motion modules supported by the software
Controller	display controller modules supported by the software
Vendor	display a particular vendor's module profiles that are installed on the system.
Other	display modules that do not fit under the rest of the check box categories.

Select All

Click on this button to display all modules in the list box; all the check boxes in the Show field are checked.

Clear All

Click on this button to clear all check boxes in the Show field.

4. In the *Type* field, select the appropriate motion module. For the purposes of this chapter select a **1756-HYD02 2 Axis Hydraulic Servo, 1756-M02AE 2 Axis Analog/Encoder Servo, or 1756-M02AS 2 Axis Analog/SSI Servo**. Whichever you select, the remaining steps and screens are the same.

5. Select **OK**. The Module Create Wizard displays.

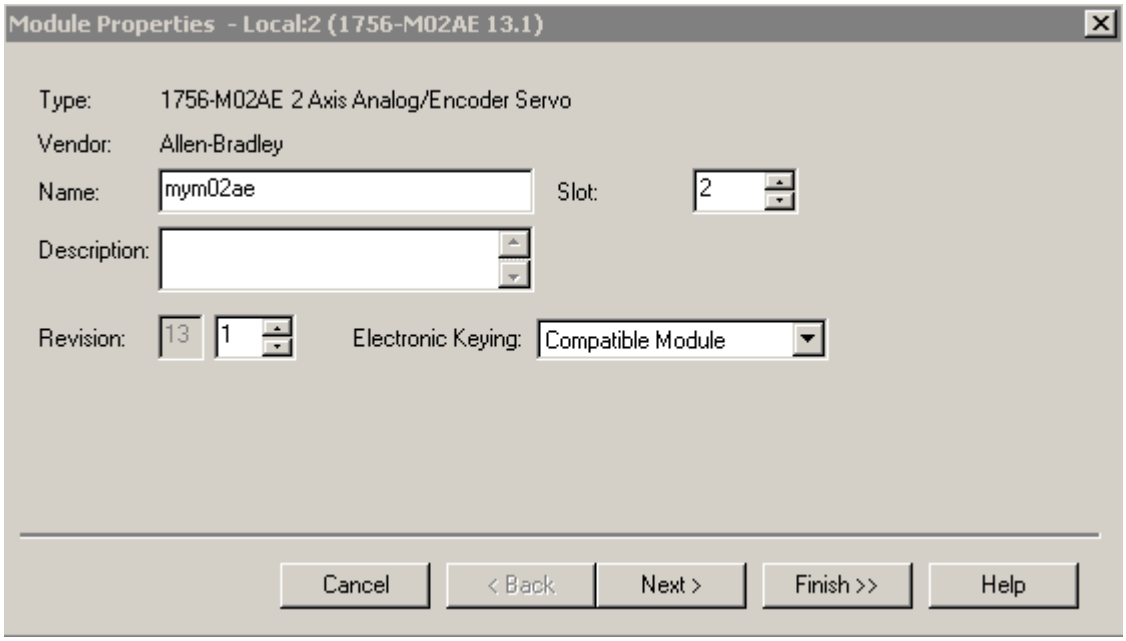


Figure 3.4 Module Properties Dialog Wizard - Naming the Module

6. Make entries in the following fields.

Field	Entry
Name	Type a name for the servo module. The name can: • have a maximum of 40 characters • contain letters, numbers and underscores (_).
Slot	Enter the number of the chassis slot that contains your module.
Description	Type a description for your motion module. This field is optional.
Revision	The major revision portion is already filled in based on the version of the software that you are running. The motion modules are lockstepped with the software and share the major revision number. The minor revision can be changed to match the minor revision of the module.

Field	Entry	
Electronic keying	Select the electronic keying level.	
	To	**Select**
	Match the vendor, catalog number, and major revision attributes of the physical module and the software configured module	Compatible module
	Disable the electronic keying protection mode	Disable keying
	Match the vendor, catalog number, major revision, and minor revision attributes of the physical module and the software configured module	Exact match

7. Press the Next button to proceed to the next Create Wizard screen.

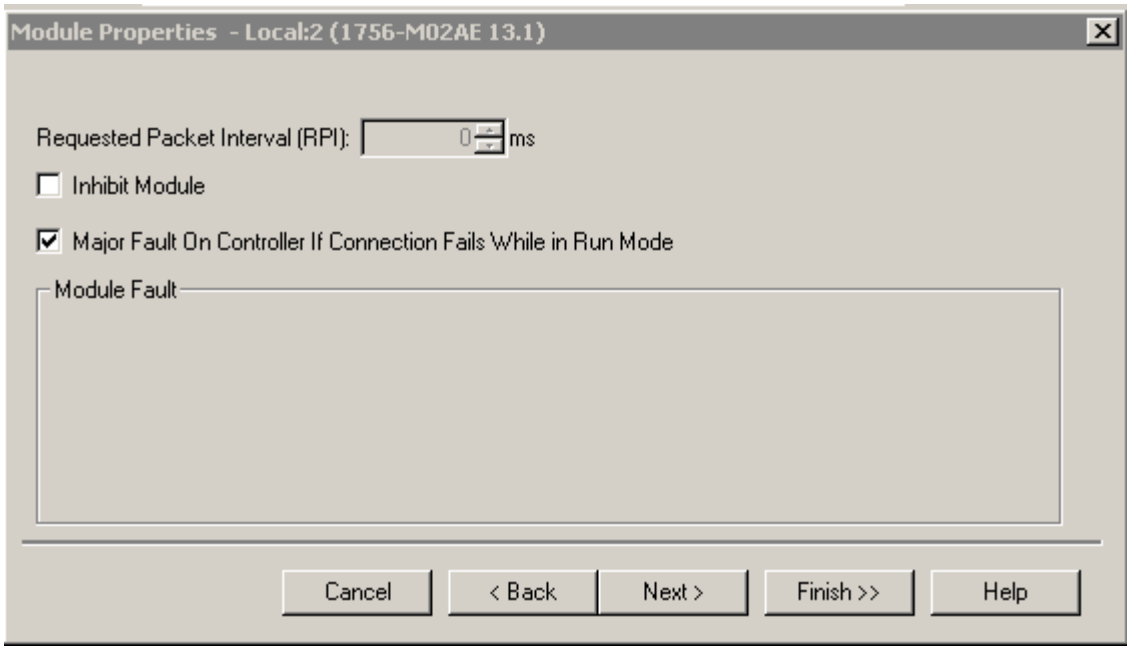


Figure 3.5 Module Properties Wizard - Fault Handling

8. This screen is where you determine how faults are to be handled. The choices are to inhibit module or to configure the module so that a loss of connection to this module causes a major fault. Make your entries and press the Next button to proceed to the next wizard screen.

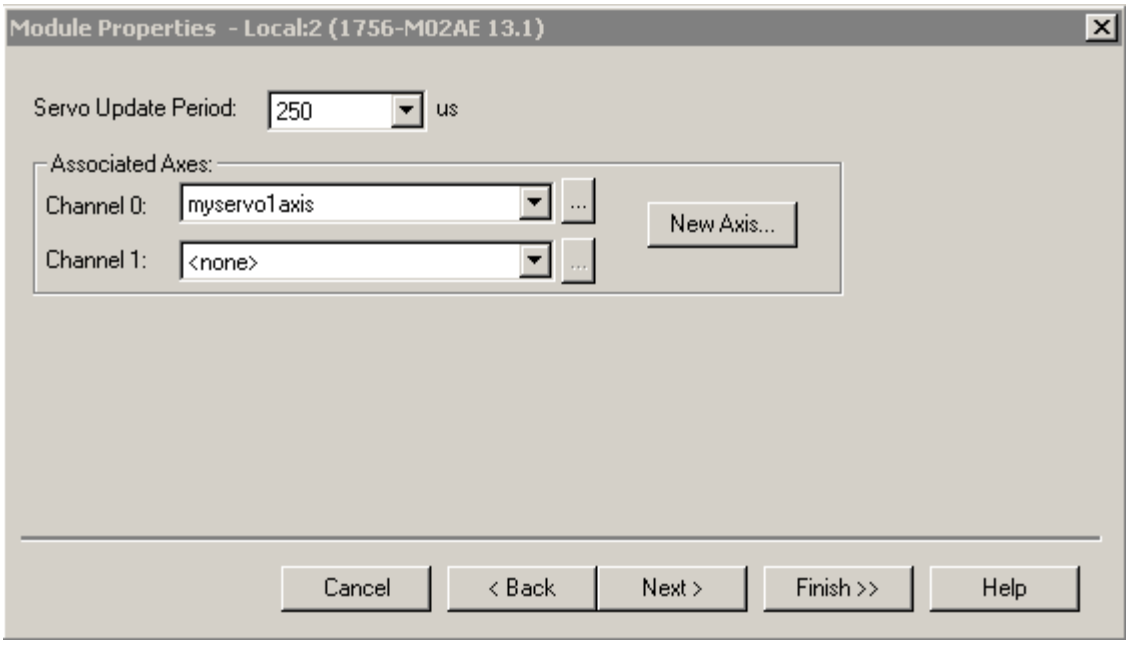


Figure 3.6 Module Properties Wizard - Servo Update/Associated Axis

9. This screen lets you associate an axis with the module. Make the appropriate choices for your application. At this point, the rest of the screens are informational only and it would be best to press the Finish button to create the module.

All of the above screens can be accessed and edited by going to the tabbed Module Property screens. Further explanations of the fields in this dialog are detailed below.

Editing Your Motion Module Settings

The following section provides explanations of the Motion Module Properties screens. Use these screens to edit the properties of the module when changes need to be made. You can access the Module Properties screen by highlighting the motion module and right clicking the mouse.

Select **Properties** from the displayed pop-up menu screen as shown in the following figure.

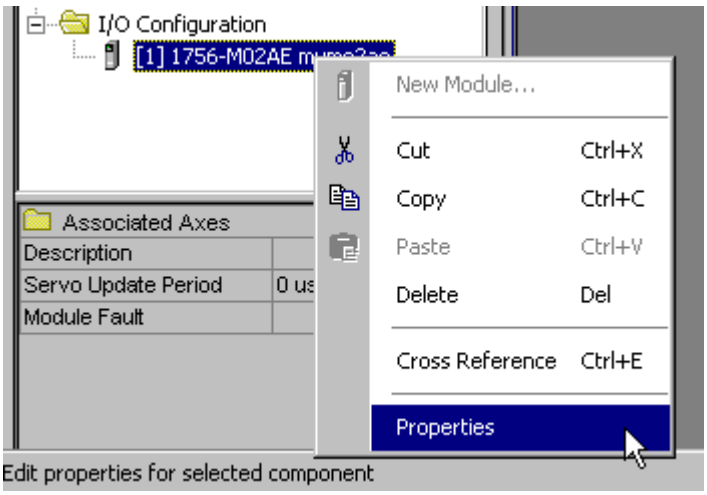


Figure 3.7 Controller Organizer - Module Properties Pop up

This accesses the Module Properties screen. The screen is tabbed to expedite movement to the required dialog.

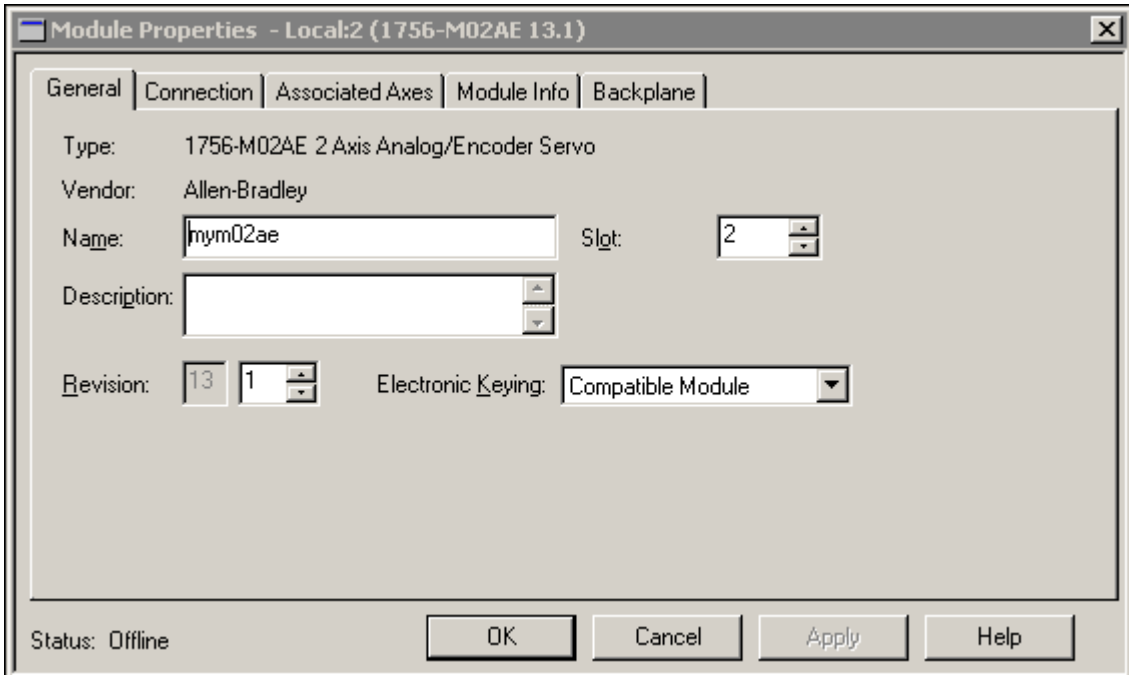


Figure 3.8 Module Properties - General Tab

General Tab Use this tab to create/view module properties for 1756-M02AE motion module. This dialog provides you with the means to view the type, description, vendor, and the name of the parent module. You can also enter the name and a description for the module. Other fields and buttons on this dialog let you set the slot location of the module,

review information for both channels, go to the New Tag dialog to create an axis to associate with one of the channels, select the minor revision number and select an electronic keying option. You can also view the status the controller has about the module but, only when online.

Type

Displays the type and description of the module being created (read only).

Vendor

Displays the vendor of the module being created (read only).

Name

Enter the name of the module.

The name must be IEC 1131-3 compliant. If you attempt to enter an invalid character or exceed the maximum length, the software beeps and ignores the character.

Description

Enter a description for the module here, up to 128 characters. You can use any printable character in this field. If you exceed the maximum length, the software beeps to warn you, and ignores any extra characters.

Slot

Enter the slot number where the module resides. The spin button contains values that range from 0 to 1 less than the chassis size (e.g., if you have a 4-slot chassis, the spin button will spin from 0 to 3). If you enter a slot number that is out of this range, you will receive an error message when you go to apply your changes.

The slot number cannot be changed when online.

Revision

Select the minor revision number of your module.

The revision is divided into the major revision and minor revision. The major revision displayed cannot be changed as the major revision number of the module is lockstepped with the major revision of the software that you have running on your system.

Electronic Keying

Select one of these keying options for your module during initial module configuration:

- Exact Match - all of the parameters must match or RSLogix rejects the inserted module.
  - Vendor
  - Product Type
  - Catalog Number
  - Major Revision
  - Minor Revision
- Compatible Module
  - the Module Types, Catalog Number, and Major Revision must match
  - the Minor Revision of the physical module must be equal to or greater than the one specified in the software or RSLogix 5000 will reject the inserted module.
- Disable Keying - RSLogix 5000 will not employ keying at all.

When you insert a module into a slot in a ControlLogix chassis, RSLogix 5000 compares the following information for the inserted module to that of the configured slot:

- Vendor
- Product Type
- Catalog Number
- Major Revision
- Minor Revision

This feature prevents the inadvertent insertion of the wrong module in the wrong slot.

Connection Tab

The Connection Tab is used to define controller to module behavior. This is where you select a requested packet interval, choose to inhibit

the module, configure the controller so loss of the connection to this module causes a major fault, and view module faults.

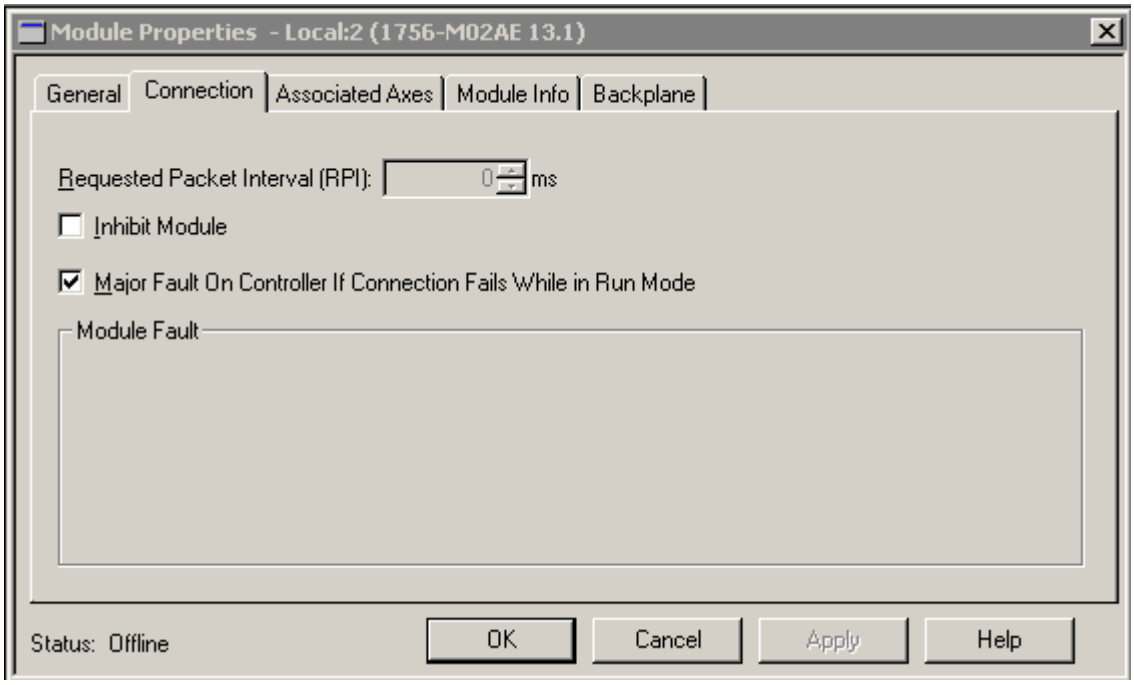


Figure 3.9 Module Properties - Connection Tab

The data on this tab comes directly from the controller. This tab displays information about the condition of the connection between the module and the controller.

Requested Packet Interval

This does not apply to motion modules.

Inhibit Module checkbox

Check/Uncheck this box to inhibit/uninhibit your connection to the module. Inhibiting the module causes the connection to the module to be broken.

TIP Inhibiting/uninhibiting connections applies mainly to direct connections, and not to the CNB module

ATTENTION Inhibiting the module causes the connection to the module to be broken and may result in loss of data

When you check this box and go online, the icon representing this module in the controller organizer displays the Attention Icon.

If you are:	Check this checkbox to:
offline	put a place holder for a module you are configuring
online	stop communication to a module If you inhibit the module while you are online and connected to the module, the connection to the module is nicely closed. The module's outputs go to the last configured Program mode state. If you inhibit the module while online but a connection to the module has not been established (perhaps due to an error condition or fault), the module is inhibited. The module status information changes to indicate that the module is 'Inhibited' and not 'Faulted'. If you uninhibit a module (clear the checkbox) while online, and no fault condition occurs, a connection is made to the module and the module is dynamically reconfigured (if you are the owner controller) with the configuration you have created for that module. If you are a listener (have chosen a "Listen Only" Communications Format), you can not re-configure the module. If you uninhibit a module while online and a fault condition occurs, a connection is not made to the module.

Major Fault on Controller if Connection Fails checkbox

Check this box to configure the controller so that failure of the connection to this module causes a major fault on the controller if the connection for the module fails.

Module Fault

Displays the fault code returned from the controller (related to the module you are configuring) and the text detailing the Module Fault that has occurred.

The following are common categories for errors:

- Connection Request Error - The controller is attempting to make a connection to the module and has received an error . The connection was not made.
- Service Request Error - The controller is attempting to request a service from the module and has received an error. The service was not performed successfully.
- Module Configuration Invalid - The configuration in the module is invalid. (This error is commonly caused by the Electronic Key Passed fault).

- Electronic Keying Mismatch - Electronic Keying is enabled and some part of the keying information differs between the software and the module.

Associated Axes Tab

This tab lets you assign axis tags to specific channels of the servo module. Use this tab to configure the selected 1756-M02AE motion modules by:

- setting the selected 1756-M02AE motion module's Servo Update Period
- associating axis tags, of the type AXIS_SERVO, with channels 0 and 1

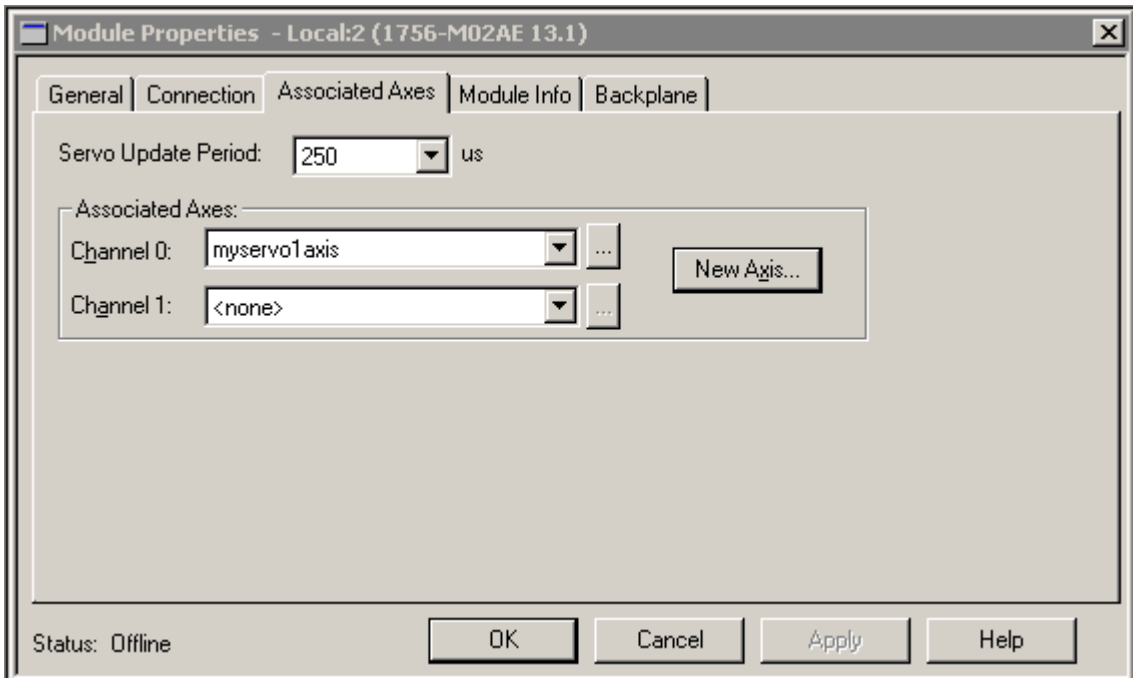


Figure 3.10 Module Properties - Associated Axis Tab

Servo Update Period

Selects the periodic rate at which the 1756-M02AE module closes the servo loop for the axis, in microseconds (µs).

Channel 0

Represents Channel 0 on the servo module. This field allows you to associate an AXIS_SERVO tag with channel 0. This field transitions to a read-only state while online. Associating an existing axis with an Hydraulic or SSI module may cause changes to the axis configuration. Click on the button to the right of this field to open the Axis Properties dialog for the associated axis to make the appropriate changes to the axis properties. See the chapter entitled *Naming and*

Configuring Your Motion Axis for more information regarding the appropriate settings for the type of module you are adding.

Channel 1

Represents Channel 1 on the servo module. This field allows you to associate an AXIS_SERVO tag with channel 1. This field transitions to a read-only state while online. Associating an existing axis with an Hydraulic or SSI module may cause changes to the axis configuration. Click on the button to the right of this field to open the Axis Properties dialog for the associated axis to make the appropriate changes to the axis properties. See the chapter entitled *Naming and Configuring Your Motion Axis* for more information regarding the appropriate settings for the type of module you are adding.

New Axis button

Click on this button to navigate to the New Tag dialog to create an AXIS_SERVO tag to associate with one of the channels. See the chapter entitled *Naming and Configuring Your Motion Axis* in this manual for more information on creating axes with RSLogix 5000.

Module Info Tab

The Module Info tab contains information about the selected module, however, you can click on:

- Refresh – to display new data from the module.
- Reset Module – to return the module to its power-up state by emulating the cycling of power. By doing this, you also clear all faults.

The Module Info Tab displays module and status information about the module. It also allows you to reset a module to its power-up state. The information on this tab is not displayed if you are offline or currently creating a module.

Use this tab to determine the identity of the module.

The data on this tab comes directly from the module. If you selected a Listen-Only communication format when you created the module, this tab is not available.

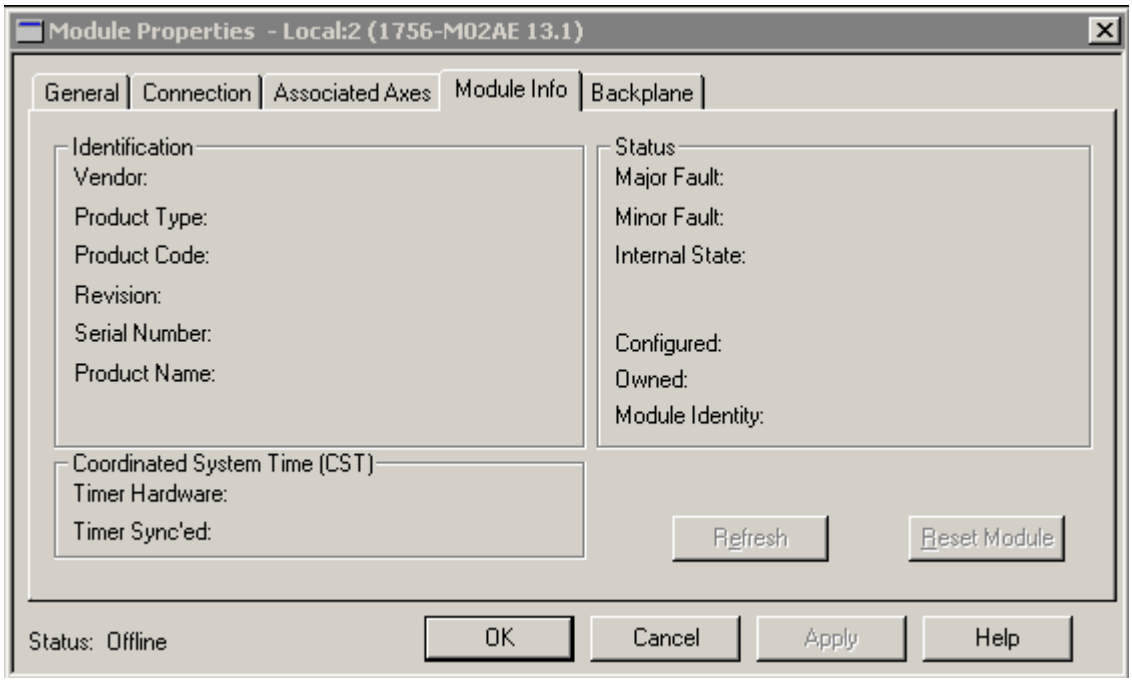


Figure 3.11 Module Properties - Module Info Tab

Identification

Displays the module's:

- Vendor
- Product Type
- Product Code
- Revision Number
- Serial Number
- Product Name

The name displayed in the Product Name field is read from the module. This name displays the series of the module. If the module is a 1756-L1 module, this field displays the catalog number of the memory expansion board (this selection applies to any controller catalog number even if additional memory cards are added: 1756-L1M1, 1756-L1M2).

Major/Minor Fault Status

If you are configuring a:	This field displays one of the following:
digital module	EEPROM fault Backplane fault None
analog module	Comm. Lost with owner Channel fault None
any other module	None Unrecoverable Recoverable

Internal State Status

This field displays the module's current operational state.

- Self-test
- Flash update
- Communication fault
- Unconnected
- Flash configuration bad
- Major Fault
- Run mode
- Program mode
- (16#xxxx) unknown

If you selected the wrong module from the module selection tab, this field displays a hexadecimal value. A textual description of this state is only given when the module identity you provide is a match with the actual module.

Configured

This field displays a yes or no value indicating whether the module has been configured by an owner controller connected to it. Once a module has been configured, it stays configured until the module is reset or power is cycled, even if the owner drops connection to the module.

Owned

This field displays a yes or no value indicating whether an owner controller is currently connected to the module.

Module Identity

Displays:	If the module in the physical slot:
Match	agrees with what is specified on the General Tab. In order for the Match condition to exist, all of the following must agree: • Vendor • Module Type (the combination of Product Type and Product Code for a particular Vendor) • Major Revision
Mismatch	does not agree with what is specified on the General Tab

This field does not take into account the Electronic Keying or Minor Revision selections for the module that were specified on the General Tab.

Refresh

Click on this button to refresh the tab with new data from the module.

Reset Module

Click on this button to return a module to its power-up state by emulating the cycling of power.

Resetting a module causes all connections to or through the module to be closed, and this may result in loss of control.

IMPORTANT The following modules return an error if a reset is attempted:1756-L1 ControlLogix5550 Programmable Controller; 1336T AC Vector Drive; 1395 Digital DC Drive.

A controller cannot be reset.

Backplane Tab

The Backplane tab on the Module Properties window is displayed for informational purposes. You can use this tab to review diagnostic information about the module's communications over the backplane and the chassis in which it is located, clear a fault, and set the transmit retry limit.

Information on this tab is displayed only if you are online.

If you selected a Listen-Only communication format when you created the module , this tab is not available.

The data on this tab comes directly from the module.

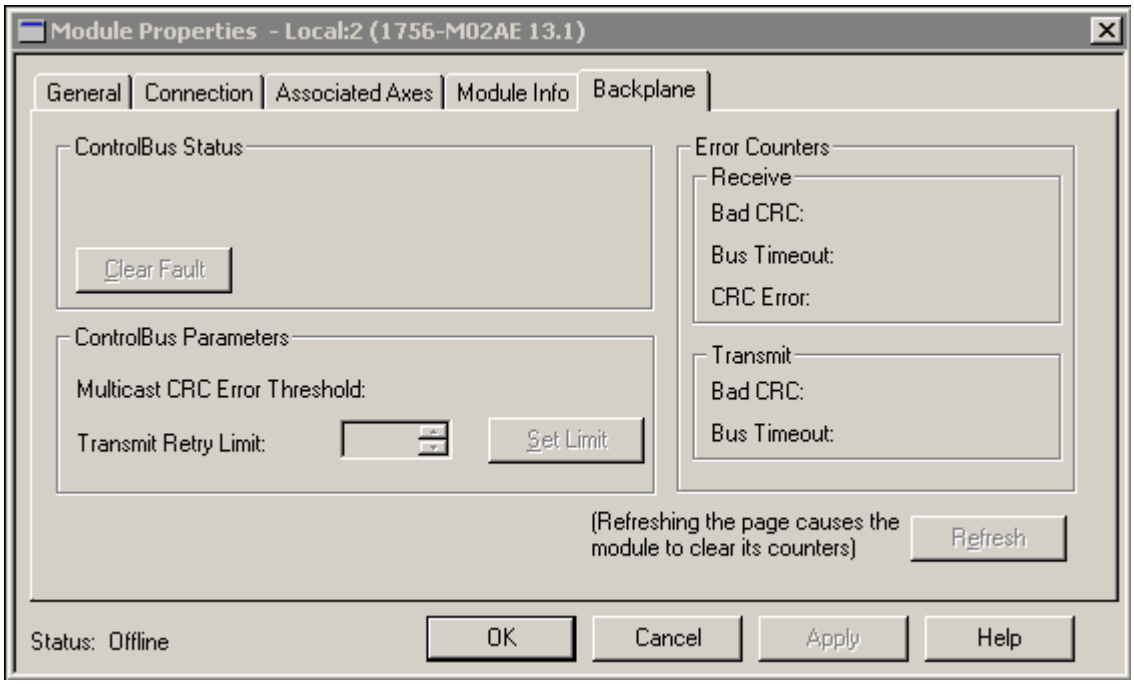


Figure 3.12 Module Properties - Backplane Tab

ControlBus Status

This box either displays OK or one of the following errors:

- Receiver disabled
- Multicast addresses disabled
- RA/GA miscompare

To clear the module's backplane fault, click the Clear Fault button .

ControlBus Parameters

This box contains the following fields and button.

Multicast CRC Error Threshold

This value is the point where it enters a fault state because of Cyclic Redundancy Check (CRC) errors.

Transmit Retry Limit

Not applicable to motion module.

Set Limit Button

You must click on the Reset Limit button to make the new Transmit Retry Limit effective. If you do not and then click either the OK or the Apply button, this limit is not set.

Receive Error Counters

This box displays the number of receiving errors that occurred in the following categories:

- Bad CRC – errors that occurred on received frames (messages)
- Bus time-out – when the receiver timed out
- CRC error – multicast receive errors

Transmit Error Counters

This box displays the number of transmitting errors that occurred in the following categories:

- Bad CRC – errors that occurred on transmitted frames
- Bus Time-out – when the transmitter bus timed out

Refresh

Click on the Refresh button to refresh the tab. When you refresh the tab:

if you're using:	then:
digital, analog, or motion modules	counters are cleared
another module	the tab is refreshed but the counters are not cleared

Assigning Additional Motion Modules

You can assign additional modules by repeating the preceding sections. You can assign up to 16 1756-M02AE modules to each Logix5000 controller. Each module uses a maximum of two axes.

Configuring the 1756-M03SE, 1756-M08SE, or 1756-M16SE Module

Adding the 1756-M03SE, 1756-M08SE, or 1756-M16SE

This chapter reviews the necessary steps for configuring the 1756-M03SE, 1756-M08SE, or 1756-M16SE motion module. Much of this information is the same as for adding and configuring the 1756-M02AE as discussed in the previous chapter.

To configure a 1756-M03SE, 1756-M08SE, or 1756-M16SE motion module:

1. In the Controller Organizer, right mouse click on I/O Configuration.

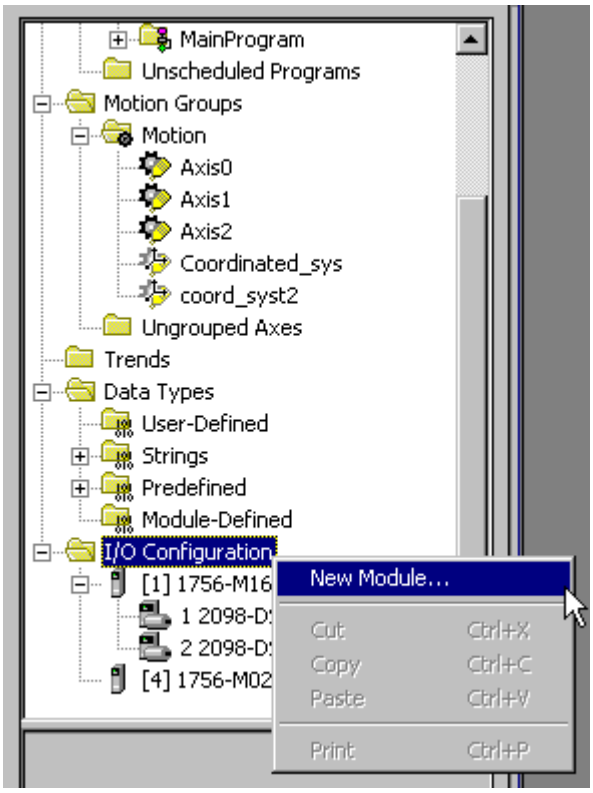


Figure 4.1 Controller Organizer | I/O Configuration| New Module

2. Or in the File menu, select New Component then Module…

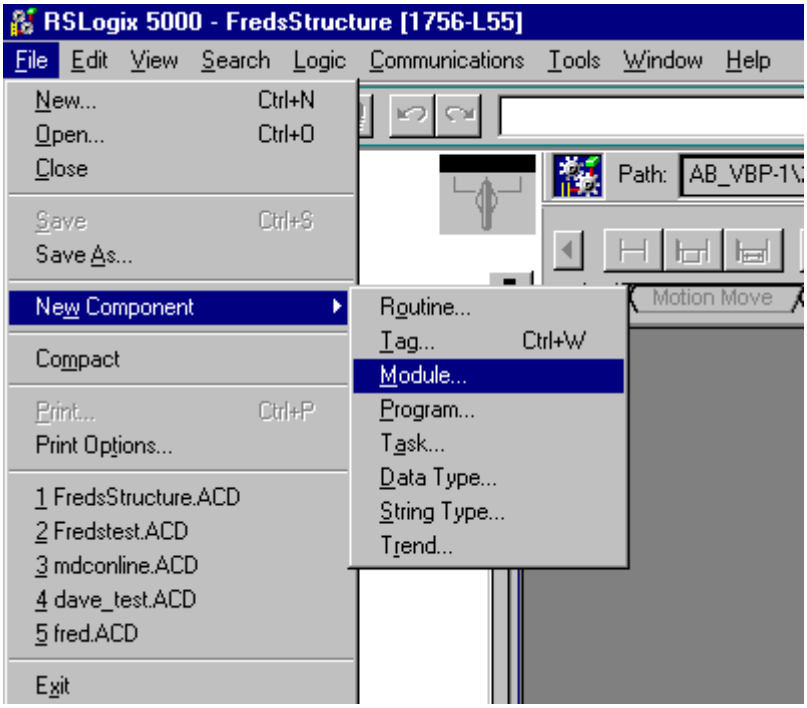


Figure 4.2 File Menu | New Component | Module Selected

3. The Select Module Type screen displays. Select Clear All. Select Motion. The list displays only available motion modules.

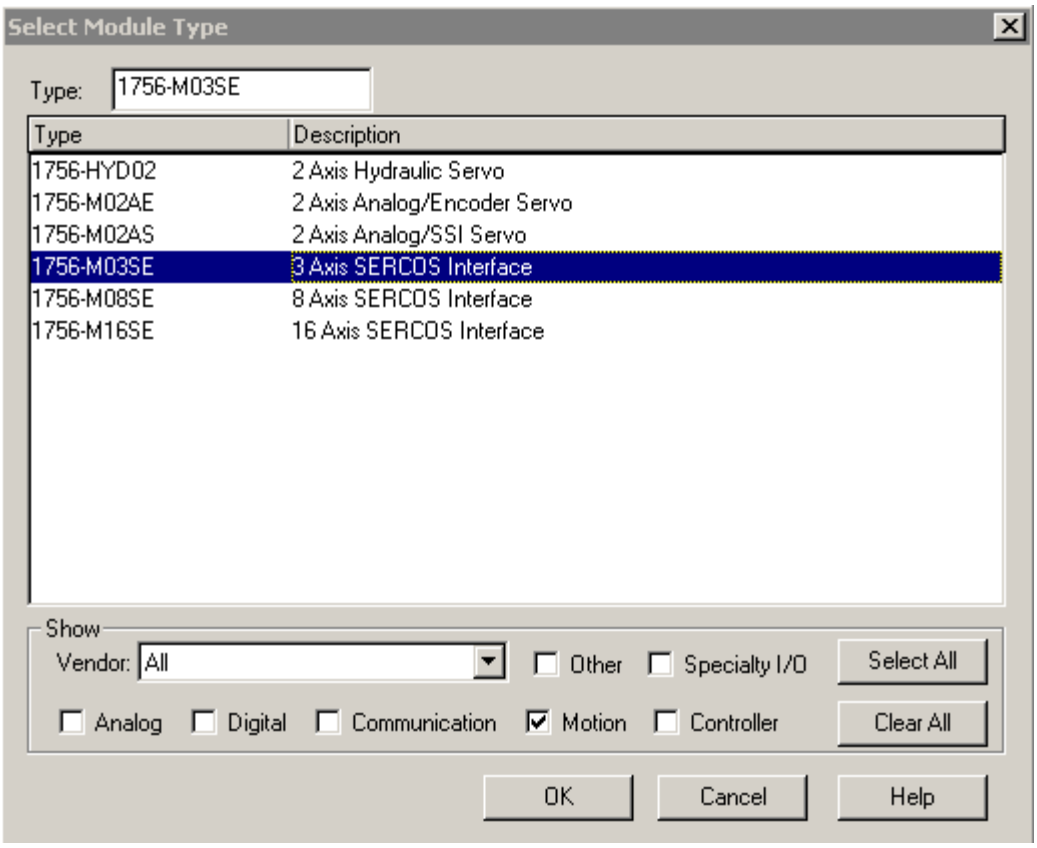


Figure 4.3 Select Module Type Screen with Motion Options - 1756-M03SE Selected

4. Select 1756-M03SE, 1756-M08SE, or 1756-M16SE.

5. Press the OK button to close the Select Module Type dialog.

6. The Create Module Wizard opens.

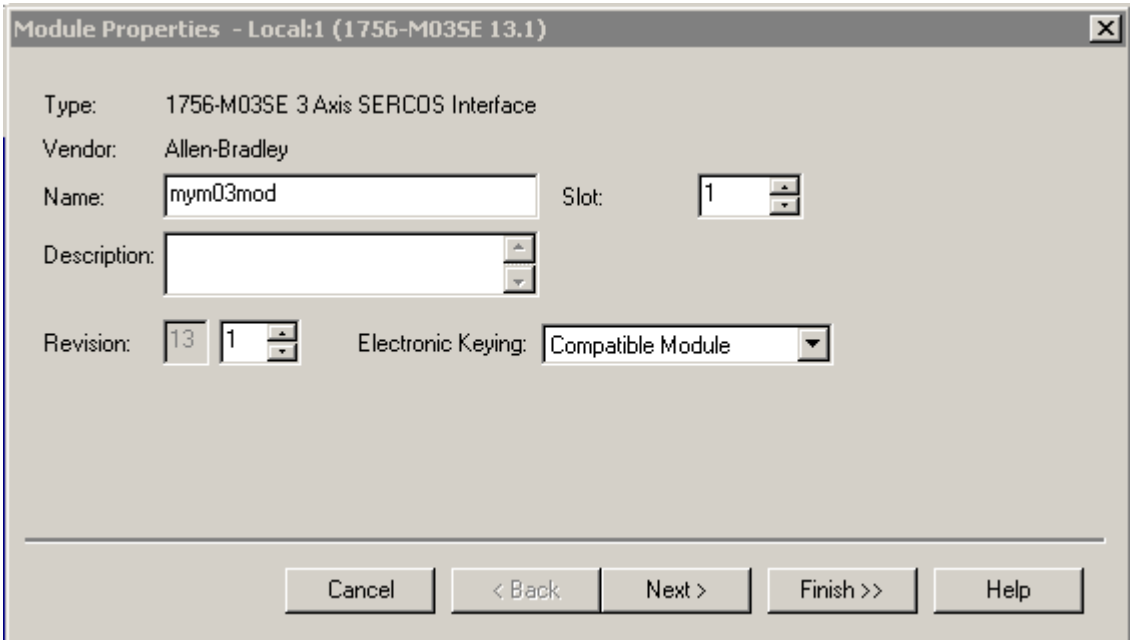


Figure 4.4 Module Properties Wizard Dialog - Name the Module

7. Name is the only required field that must be entered to create the M03SE/M08SE/M16SE module. It must conform to the IEC 1131-3 standard. You can also enter a description for the module, select the minor revision number of your module, and select the method for Electronic Keying. Fill in the at least the required Name field and click the Next> button to advance to the next wizard screen to enter Connection information or click on the Finish>> button to create the module. You can then go to the Module Properties screen to edit any values. (See the section titled *SERCOS interface Motion Module Overview* in this chapter for more information on the fields in these screens.)

8. The Connection Screen Wizard displays.

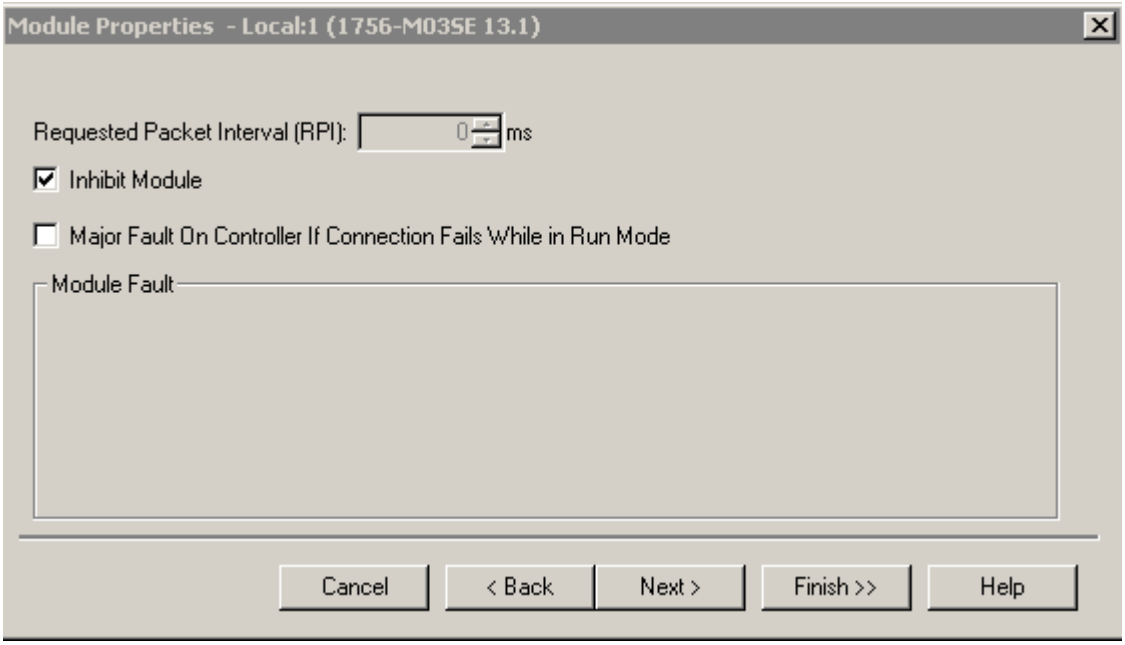


Figure 4.5 Module Properties Wizard Dialog - Connection Screen

9. On this screen there are no required fields but you can enter how you want to handle connection faults. The Requested Packet Interval (RPI) field does not pertain to the SERCOS interface modules and is greyed out.

Inhibit Module defaults to Unchecked. Click on the check box to inhibit the module.

Major Fault on Controller ... check box defaults to uncheck. Click on the box if you want to check this option. Click on Next> to advance the SERCOS interface Create Wizard screen.

10. The SERCOS interface screen displays.

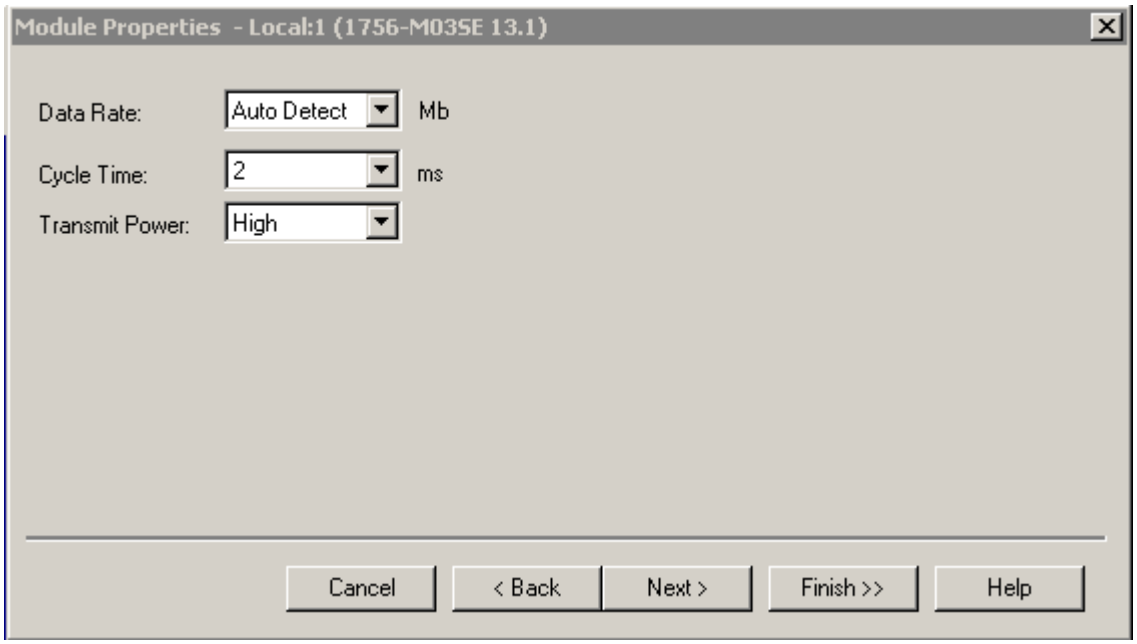


Figure 4.6 Module Properties Wizard Dialog - SERCOS interface Screen

11. On this screen you can enter the Data Rate, SERCOS ring Cycle time, and the transmit power for the SERCOS ring.

The rest of the Create Wizard screens are only informational and do not let you enter any information. It saves time if you click on the Finish>> button at this time.

12. The 1756-M08SE/-M16SE motion module appears in the I/O Configuration branch of the Controller Organizer. It can now be put into use or edited as you require.

SERCOS interface Motion Module Overview

The 1756-M03SE/-M08SE/-M16SE SERCOS interface motion module has been added. To edit the 1756-M03SE/-M08SE/-M16SE Module Properties, go to the I/O Configuration organizer and right click on

the 1756-M03SE/-M08SE/-M16SE module and select Properties from the drop down menu. The tabbed Module Properties screen displays.

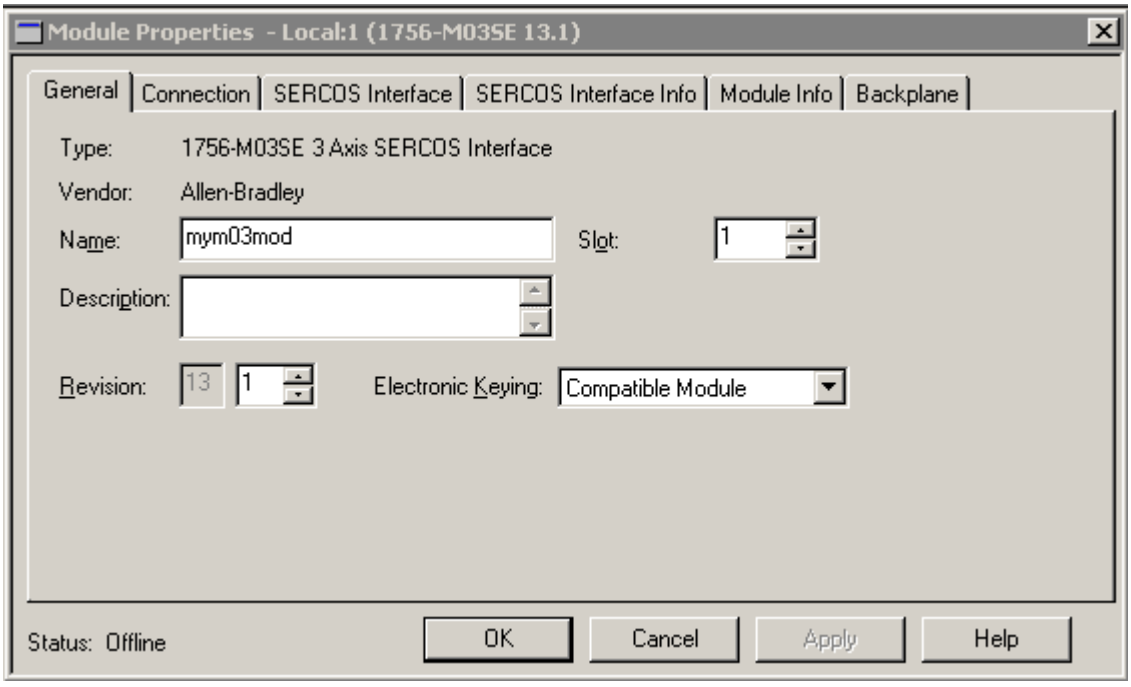


Figure 4.7 Module Properties - General Tab

The Module Properties screen has the following tabs:

- The General tab references the 1756-M03SE/-M08SE/-M16SE motion module.
- The Connection tab references the connection of the module to the controller.
- The SERCOS Interface tab is for configuring SERCOS communication settings for the 1756-M03SE/-M08SE/-M16SE motion module.
- The SERCOS Interface Info tab is used to monitor the status of the SERCOS communication ring.
- The Module Info tab, when Online, displays the current condition of the module.
- The Backplane tab, when Online, displays diagnostic information about the module's communication over the backplane and the chassis in which it is located.

Editing 1756-M03SE/-M08SE/-M16 SE Module Properties

General Tab

Use this tab to create/view module properties for the 1756-M03SE/-M08SE/-M16SE motion module.

On this tab, you can:

- view the type and description of the module being created
- view the vendor of the module being created
- enter the name of the module
- enter a description for the module
- select the slot number of the module on the network
- select the minor revision number of your module
- select Exact Match, Compatible Module, or Disable Keying

Type

Displays the type and description of the module being created (read only).

Vendor

Displays the vendor of the module being created (read only).

Name

Enter the name of the module. The name must be IEC 1131-3 compliant. An error message is displayed if you enter an invalid character or a duplicate name. If you exceed the maximum length, the software ignores the extra characters.

Description

Enter a description for the module here, up to 128 characters. You can use any printable character in this field. If you exceed the maximum length, the software ignores any extra characters.

Slot

Enter the slot number where the module resides. The spin button contains values that range from 0 to 1 less than the chassis size (e.g., if you have a 4-slot chassis, the spin button spins from 0 to 3). Only available slot numbers are listed by the spin button. However, you can

edit the slot number manually. If you enter a slot number that is out of this range, you receive an error message when you apply your changes.

The slot number cannot be changed when online.

Revision

The revision is divided into the major revision and minor revision. The major revision displayed statically is chosen on the Select Module Type dialog.

The major revision is used to indicate the revision of the interface to the module. The minor revision is used to indicate the firmware revision.

Select the minor revision number of your module.

Electronic Keying

Select one of these keying options for your module during initial module configuration:

Exact Match - all of the parameters must match or the inserted module rejects the connection.

Compatible Module - the Module Types, Catalog Number, and Major Revision must match. The Minor Revision of the physical module must be equal to or greater than the one specified in the software or the inserted module rejects the connection.

Disable Keying – Controller does not employ keying at all.

ATTENTION

Changing the Electronic Keying selection may cause the connection to the module to be broken and may result in a loss of data.

Be extremely cautious when using this option; if used incorrectly, this option can lead to personal injury or death, property damage or economic loss.

Status – This is a Read Only field that displays the Controllers current opinion of the module.

Standby – A transient state that occurs when shutting down.

Faulted – It is unable to communicate with the module. When Faulted is displayed, check the Connection Tab fore the fault listing.

Validating – A transient state that occurs prior to connecting to the module.

Connecting – The state while the connection(s) to the module are established.

Running – The module is communicating and everything is working as expected.

Shutting Down – The connections are in the process of closing.

Inhibited – The module is prevented from connecting to the controller.

Waiting – A connection to this module has not been made due to one of the following reasons.

- Its parent has not yet made a connection to it.
- Its parent is inhibited.
- Its parent is faulted.

Offline – The module is not currently online.

When you insert a module into a slot in a ControlLogix chassis, RSLogix5000 compares the following information for the inserted module to that of the configured slot:

- Vendor
- Product Type
- Catalog Number
- Major Revision
- Minor Revision

This feature prevents the inadvertent insertion of the wrong module in the wrong slot.

Connection Tab

The Connection Tab reflects controller to module behavior. This is where you choose to inhibit the module, configure the controller so

loss of the connection to this module causes a major fault, and view module faults when online.

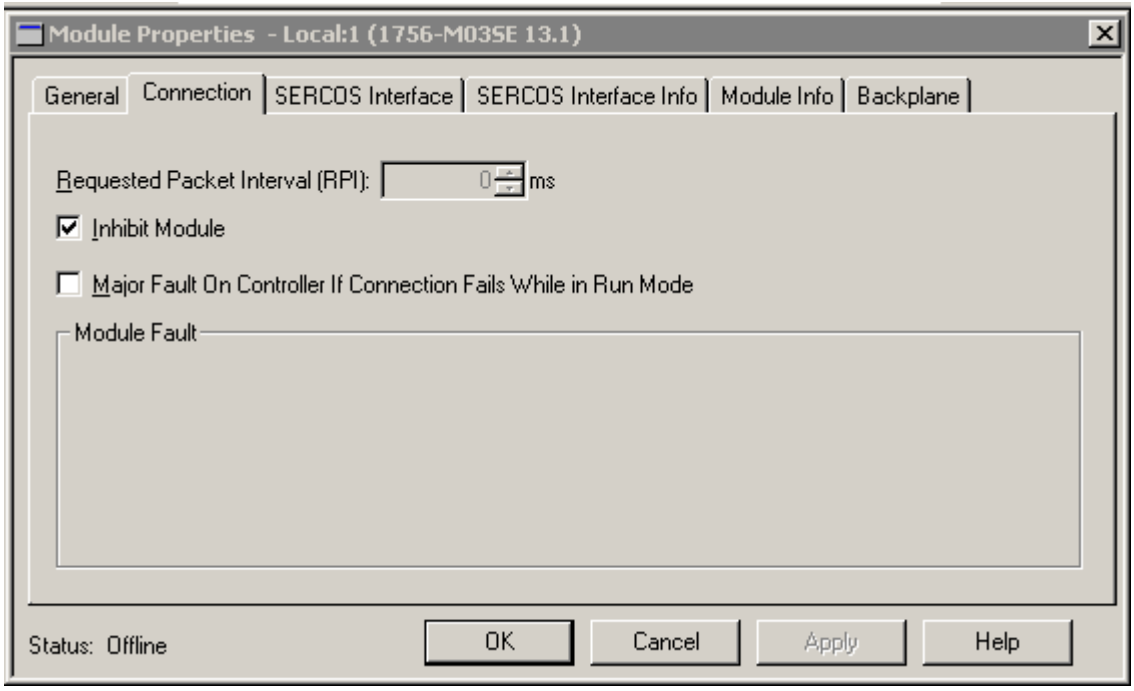


Figure 4.8 Module Properties - Connection Tab

The fault data on this tab comes directly from the controller. This tab displays information about the condition of the connection between the module and the controller.

Requested Packet Interval

This does not apply to motion modules.

Inhibit Module checkbox

Check/Uncheck this box to inhibit/uninhibit your connection to the module. Inhibiting the module causes the connection to the module to be broken. When a module is inhibited all of the associated axes are not used in the configuration process. The system ignores them as if they were not there and allows configuration and operation of any axis associated to other modules in the group.

TIP Inhibiting/uninhibiting connections applies mainly to direct connections, and not to the CNB module.

ATTENTION

Inhibiting the module causes the connection to the module to be broken and may result in loss of data.

When you check this box and go online, the icon representing this module in the controller organizer displays the Attention Icon.

If you are:	Check this checkbox to:
offline	put a place holder for a module you are configuring
online	stop communication to a module If you inhibit the module while you are online and connected to the module, the connection to the module is nicely closed. The module's outputs go to the last configured Program mode state. If you inhibit the module while online but a connection to the module has not been established (perhaps due to an error condition or fault), the module is inhibited. The module status information changes to indicate that the module is 'Inhibited' and not 'Faulted'. If you uninhibit a module (clear the checkbox) while online, and no fault condition occurs, a connection is made to the module and the module is dynamically reconfigured (if you are the owner controller) with the configuration you have created for that module. If you are a listener (have chosen a "Listen Only" Communications Format), you can not re-configure the module. If you uninhibit a module while online and a fault condition occurs, a connection is not made to the module.

Major Fault on Controller if Connection Fails checkbox

Check this box to configure the controller so that failure of the connection to this module causes a major fault on the controller if the connection for the module fails.

Module Fault

Displays the fault code returned from the controller (related to the module you are configuring) and the text detailing the Module Fault that has occurred.

The following are common categories for errors:

- **Connection Request Error** - The controller is attempting to make a connection to the module and has received an error. The connection was not made.

- **Service Request Error** - The controller is attempting to request a service from the module and has received an error. The service was not performed successfully.
- **Module Configuration Invalid** - The configuration in the module is invalid. (This error is commonly caused by the Electronic Key Passed fault).
- **Electronic Keying Mismatch** - Electronic Keying is enabled and some part of the keying information differs between the software and the module.

SERCOS Interface Tab

The SERCOS interface Tab is for configuring the SERCOS ring. It is here where you set the specific Data Rate, Cycle Time, and Transmit Power for the named 1756-M03SE/-M08SE/-M16SE SERCOS interface module.

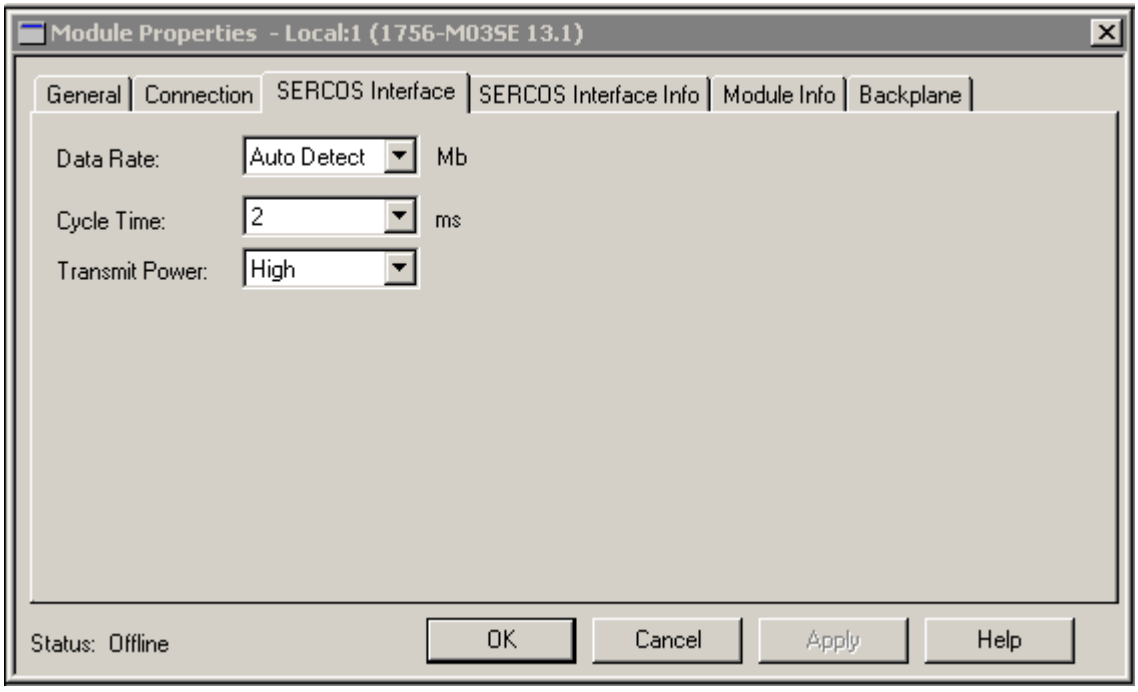


Figure 4.9 Module Properties - SERCOS Interface Tab

Use the SERCOS Interface Tab to set and display the:

- SERCOS baud rate
- update rate for the SERCOS ring
- fiber optic transmit power range for the SERCOS ring

The SERCOS ring consists of the drives and axes connected to the 1756-M03SE/-M08SE/-M16SE motion controller.

TIP The settings on this tab are specific to the 1756-M08SE/-M16SE motion controller.

Data Rate

Select the baud rate for the SERCOS ring. Your options are:

- Auto Detect – automatically scans to detect the SERCOS ring baud rate as set by the drive(s).
- 4 Mb – sets the SERCOS ring baud rate to 4 Mb. This value must match the baud rate set on the drives. All drives included in the ring must be set to 4 Mbaud.
- 8 Mb – sets the SERCOS ring baud rate to 8 Mb.This value must match the baud rate set on the drives. All drives included in the ring must be set to 8 Mbaud.

IMPORTANT If drives are set to both 4 and 8 Mbaud rates and the motion module's Data Rate is set to 4 Mbaud, it only detects the 4Mbaud drives and indicates a closed ring. Those drives set to 8 Mbaud are ignored. When the program is run it errs because the drives set to 8 Mbaud are not found.

In the above scenario with the motion module's Data Rate set to 8 Mbaud, it errs with "Wrong baud rate".

Cycle Time

This field sets the rate at which drives on the SERCOS ring are updated. Select the update rate for the SERCOS ring:

- 0.5 ms

  NOTE: Many drives to not support an update rate of 0.5 ms. Check your drive documentation for appropriate values.
- 1 ms
- 2 ms.

Transmit Power

Select the optic transmit power range for the SERCOS ring:

- High
- Low

It is recommended that you set to High.

SERCOS Interface Info Tab

The SERCOS interface Tab is for monitoring the SERCOS ring of the selected 1756-M08SE/-M16SE while it is on-line. A REFRESH button is available to access the current values.

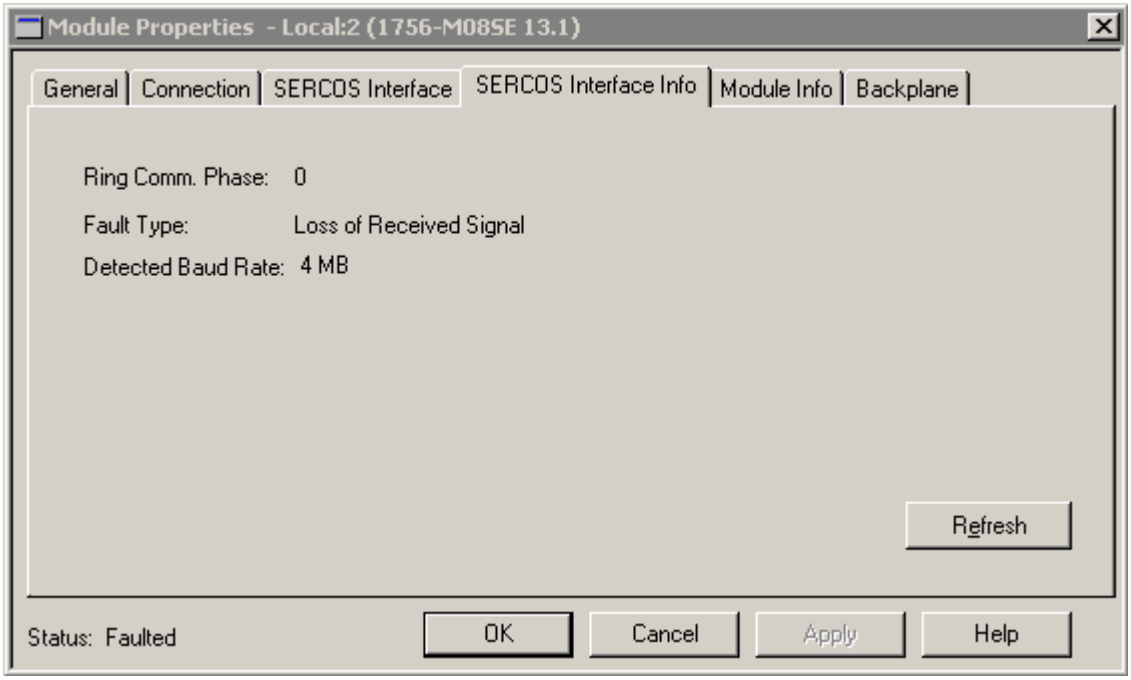


Figure 4.10 Module Properties - SERCOS Interface Info Tab

Use this tab to monitor the following:

Ring Comm. Phase

Displays the communications phase of the SERCOS ring:

0: Ring Integrity

1: Polling

2: Identity

3: Configuration

4: Cyclic communication

Fault Type

Displays the current fault type, if any, on the SERCOS ring. Values include:

- No fault
- Loss of received signal
- MST error
- Missed AT
- Excessive AT errors
- Duplicate nodes (not currently supported)
- No nodes
- Wrong ring cycle
- Wrong baud rate
- Link transport fault
- Wrong phase
- Wrong AT number

Refresh

Click this button to update this page.

Note: this information does not refresh automatically.

Module Info Tab

The Module Info tab contains information about the selected module, however, you can click on:

- Refresh – to display new data from the module.
- Reset Module – to return the module to its power-up state by emulating the cycling of power. By doing this, you also clear all faults.

The Module Info Tab displays module and status information about the module. It also allows you to reset a module to its power-up state. The information on this tab is not displayed if you are offline or currently creating a module.

Use this tab to determine the identity of the module.

The data on this tab comes directly from the module. If you selected a Listen-Only communication format when you created the module, this tab is not available.

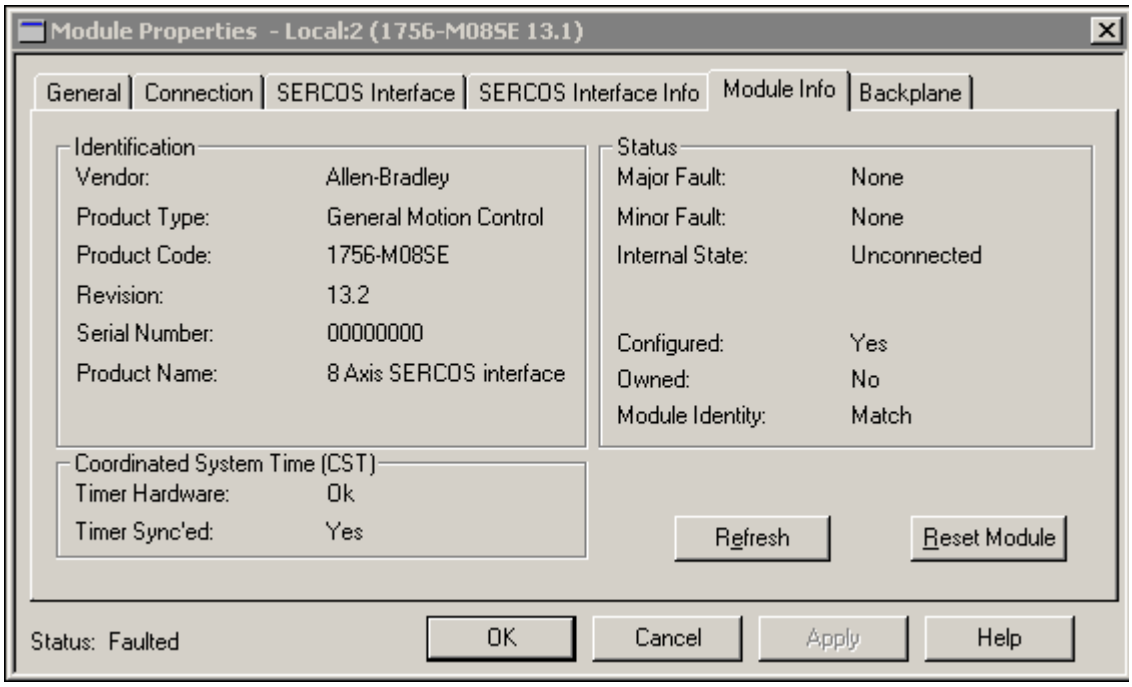


Figure 4.11 Module Properties - Module Info Tab

Identification

Displays the module's:

- Vendor
- Product Type
- Product Code
- Revision Number
- Serial Number
- Product Name

The name displayed in the Product Name field is read from the module. This name displays the series of the module.

Major/Minor Fault Status

If you are configuring a:	This field displays one of the following:
digital module	EEPROM fault Backplane fault None
analog module	Comm. Lost with owner Channel fault None
any other module	None Unrecoverable Recoverable

Internal State Status

This field displays the module's current operational state.

- Self-test
- Flash update
- Communication fault
- Unconnected
- Flash configuration bad
- Major Fault
- Run mode
- Program mode
- (16#xxxx) unknown

If you selected the wrong module from the module selection tab, this field displays a hexadecimal value. A textual description of this state is only given when the module identity you provide is a match with the actual module.

Configured

This field displays a yes or no value indicating whether the module has been configured by an owner controller connected to it. Once a module has been configured, it stays configured until the module is reset or power is cycled, even if the owner drops connection to the module.

Owned

This field displays a yes or no value indicating whether an owner controller is currently connected to the module.

Module Identity

Displays:	If the module in the physical slot:
Match	agrees with what is specified on the General Tab. In order for the Match condition to exist, all of the following must agree: • Vendor • Module Type (the combination of Product Type and Product Code for a particular Vendor) • Major Revision
Mismatch	does not agree with what is specified on the General Tab

This field does not take into account the Electronic Keying or Minor Revision selections for the module that were specified on the General Tab.

Refresh

Click on this button to refresh the tab with new data from the module.

Reset Module

Click on this button to return a module to its power-up state by emulating the cycling of power.

Resetting a module causes all connections to or through the module to be closed, and this may result in loss of control.

Backplane Tab

The Backplane tab on the Module Properties window is displayed for informational purposes. You can use this tab to review diagnostic information about the module's communications over the backplane and the chassis in which it is located, clear a fault, and set the transmit retry limit.

Information on this tab is displayed only if you are online.

If you selected a Listen-Only communication format when you created the module, this tab is not available.

The data on this tab comes directly from the module.

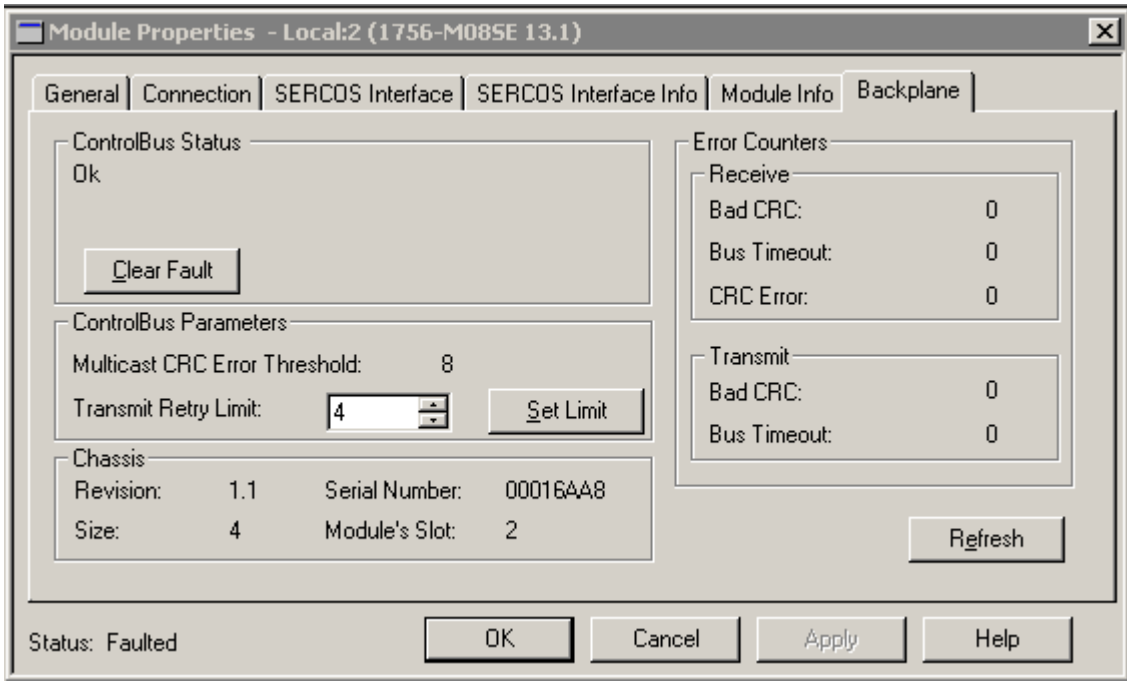


Figure 4.12 Module Properties - Backplane Tab

ControlBus Status

This box either displays OK or one of the following errors:

- Receiver disabled
- Multicast addresses disabled
- RA/GA miscompare

To clear the module's backplane fault, click the Clear Fault button.

ControlBus Parameters

This box contains the following fields and button.

Multicast CRC Error Threshold

This value is the point where it enters a fault state because of Cyclic Redundancy Check (CRC) errors.

Transmit Retry Limit

Not applicable to motion module.

Set Limit Button

You must click on the Set Limit button to make the new Transmit Retry Limit effective. If you do not and then click either the OK or the Apply button, this limit is not set.

Receive Error Counters

This box displays the number of receiving errors that occurred in the following categories:

- Bad CRC – errors that occurred on received frames (messages)
- Bus time-out – when the receiver timed out
- CRC error – multicast receive errors

Transmit Error Counters

This box displays the number of transmitting errors that occurred in the following categories:

- Bad CRC – errors that occurred on transmitted frames
- Bus Time-out – when the transmitter bus timed out

Refresh

Click on the Refresh button to refresh the tab. When you refresh the tab:

if you're using:	**then:**
digital, analog, or motion modules	counters are cleared
another module	the tab is refreshed but the counters are not cleared

The Motion Group

Creating A Motion Group

Each .acd program must have one motion group. (There can be only one.) You must create it before an axis can be assigned to the group and have it function within the .acd program.

To create the motion group, right click on Motion Group and select New Motion Group from the drop down menu.

Figure 5.1 Controller Organizer - New Motion Group Pop-up

This calls the New Tag window.

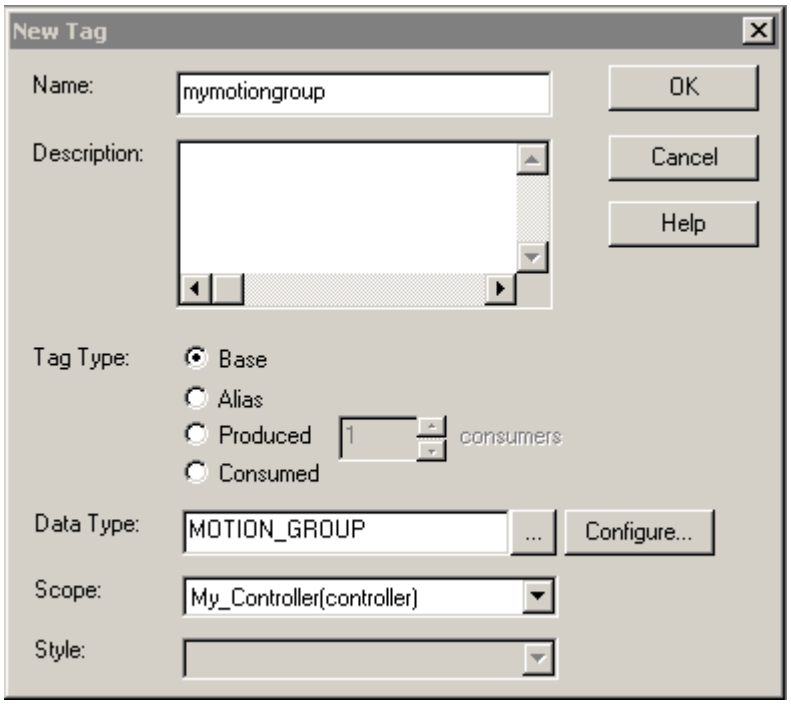


Figure 5.2 New Tag Dialog

1. Enter a name for the Motion Group in the Name field.

2. In the Description field, enter a description of the tag.

3. Click on the respective radio button to select one of the following tag types:
   - Base - refers to a normal tag (selected by default)
   - Alias - refers to a tag, which references another tag with the same definition. Special parameters appear on the New Tag dialog that allows you to identify to which base tag the alias refers.

4. Select MOTION_GROUP for the Data Type.

5. From the Scope pull-down menu, select the scope for the tag.

6. If you want to produce this tag for other controllers to consume, check the Produce box and enter the maximum number of consumers.

IMPORTANT Producing a tag requires a connection for each consumer. Connections are a limited resource in the controller, so only produce tags that you know you are needed in other controllers.

7. Click on the Configure button to proceed through the Motion Group Wizard screens to set the properties for the motion group.

   If you had clicked on OK instead of the Configure button, it would have created the group and closed the dialog. You would then need to access the Motion Group Properties screen to configure the Motion Group.

The Motion Group Wizard group - Axis Assignment screen displays.

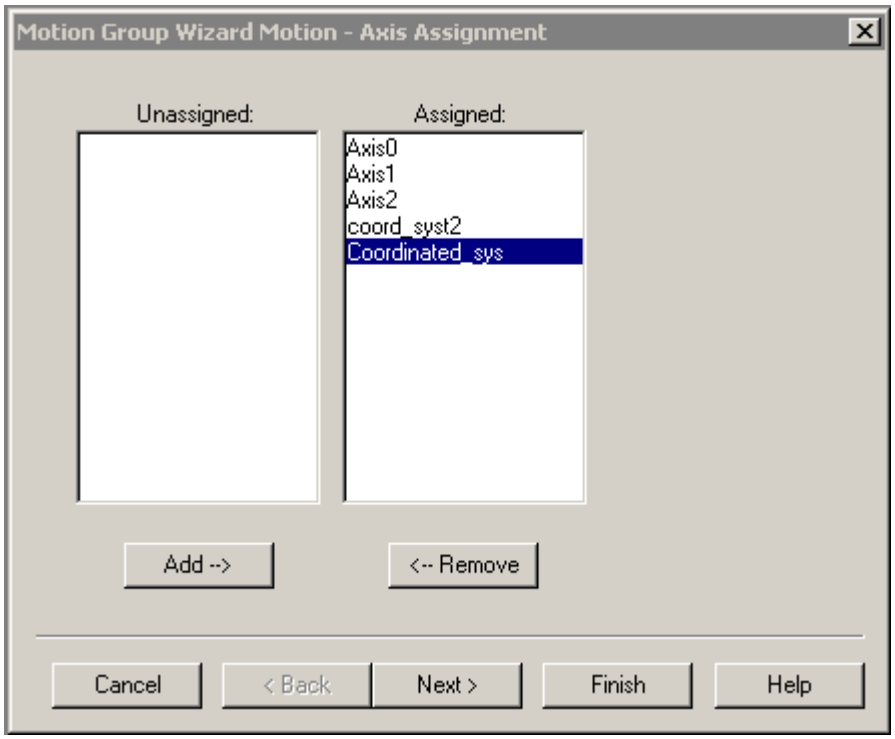


Figure 5.3 Motion Group Wizard Dialog - Axis Assignment

Add any existing axes to the group.

8. Continue on through the Motion Group Wizard to configure your Motion Group tag as necessary. Click on Finish>> to close the wizard.

Editing the Motion Group Properties

The Motion Group properties can be edited by right clicking on the group name and selecting Motion Group Properties from the drop down menu.

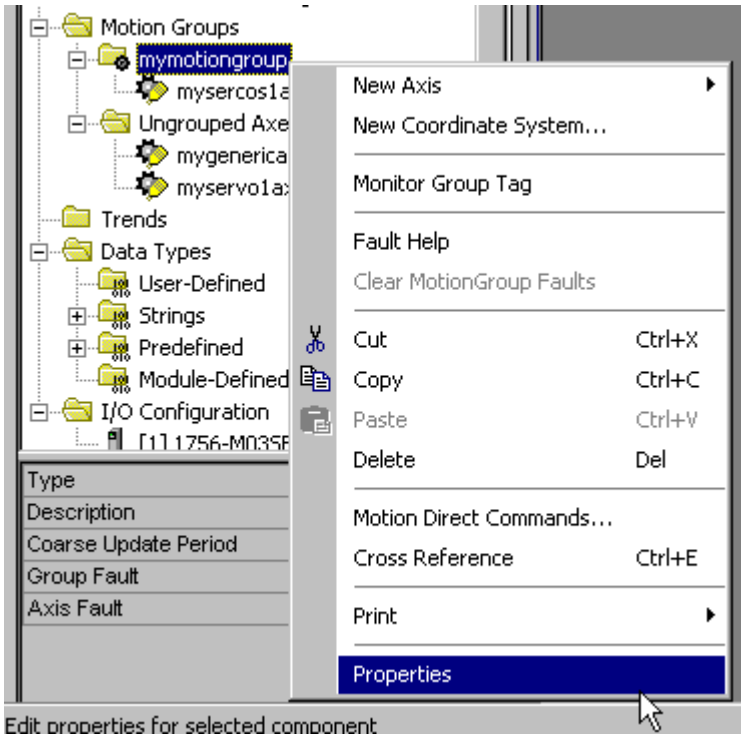


Figure 5.4 Motion Group Properties Access

The Motion Group Properties tabbed screen displays.

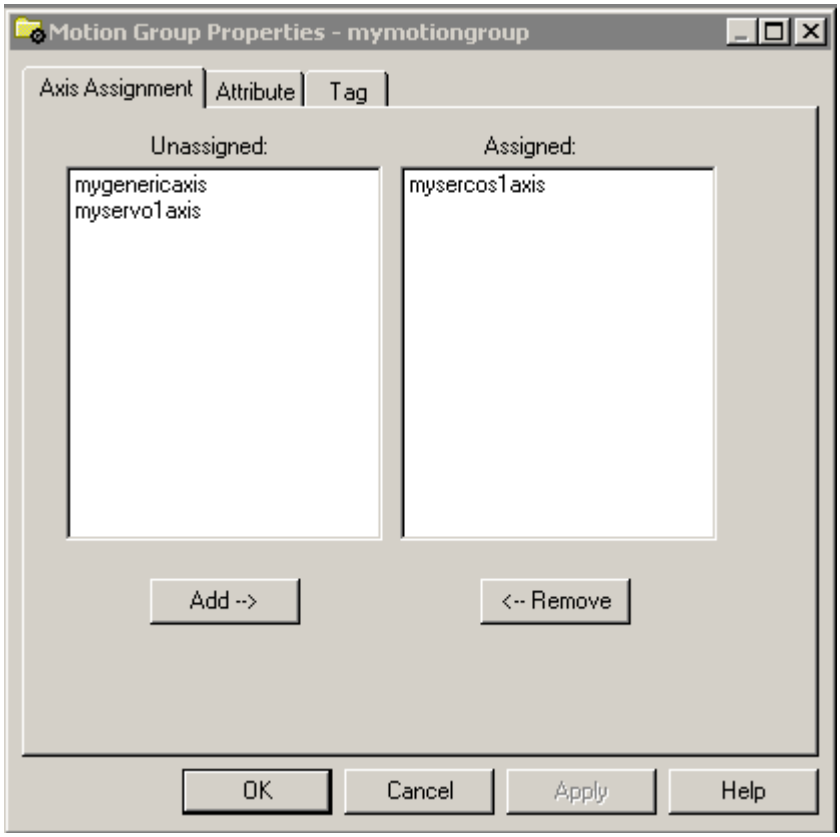


Figure 5.5 Motion Group Properties - Axis Assignment Tag

Axis Assignment Tab

The Axis Assignment screen is where axes are either assigned or unassigned to the Motion Group. When RSLogix 5000 software is online, all attributes on this dialog transition to a read-only state. When an attribute transitions to a read-only state, all pending attribute changes revert back to their offline status.

Unassigned

Lists the axes that are not assigned to any group in the controller.

Assigned

Lists the axes that are assigned to this motion group.

Add

Click on this button to add axes to the motion group.

Remove

Click on this button to remove axes from the motion group.

Attribute Tab The Attribute tab is used to modify the group attributes.

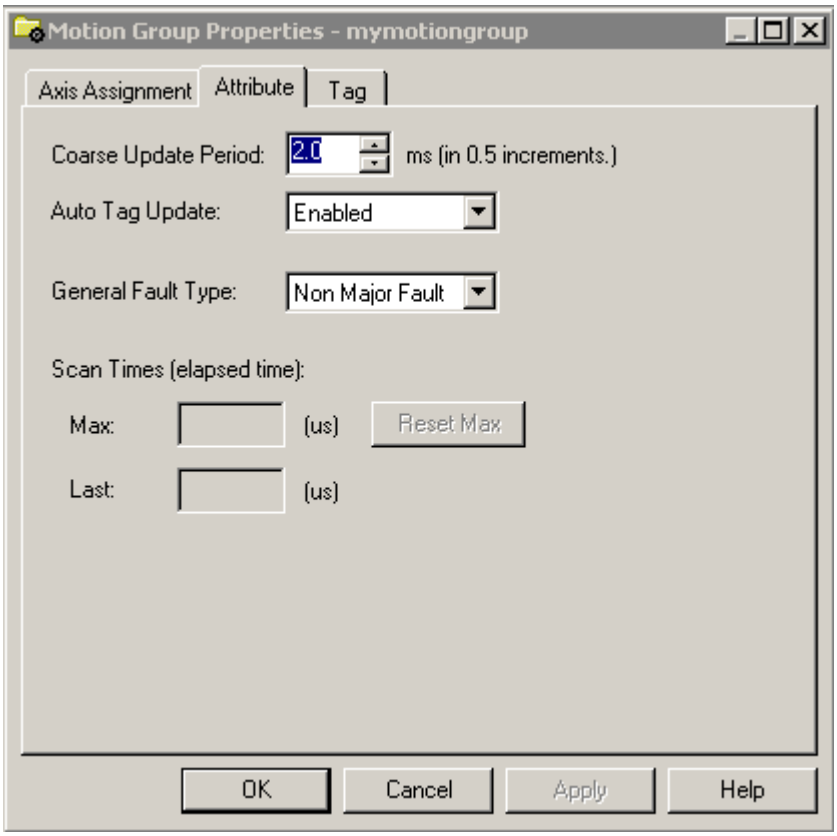


Figure 5.6 Motion Group Properties - Attribute Tag

When RSLogix 5000 software is online, all of the attributes on this tab transition to a read-only state. When an attribute transitions to a read-only state, all pending attribute changes are reverted.

Coarse Update Period

Selects the periodic rate at which the motion task executes to compute the servo commanded position, velocity, and accelerations to be sent to the 1756-M02AE or 1756-M*xx*SE modules when executing motion instructions.

Auto Tag Update

This parameter determines whether or not the axis parameter values are automatically updated during operation. Choose either:

- Enabled – turns On automatic tag updating
- Disabled – turns Off automatic tag updating

General Fault Type

Selects the general fault type mechanism for the motion group. The available selections are:

- Non Major Fault – Any faults detected by the motion group will not cause the processor to fault. The application programmer needs to handle the fault in the program.
- Major Fault – Any faults detected by the motion group will cause the processor OK light to go blinking red and the fault routine to be invoked. If the fault routine handles the fault and clears it, then the OK light turns green. If the fault routine does not clear the fault, then the OK light becomes solid red and the processor stops executing the program.

Scan Times (elapsed time)

- Max – displays the value from the previous scan; clear this value, if necessary
- Disabled – displays the value from the previous scan

Reset Max

Click on this button to clear the Scan Times Max value.

Tag Tab Use this tab to modify the name and description of the group.

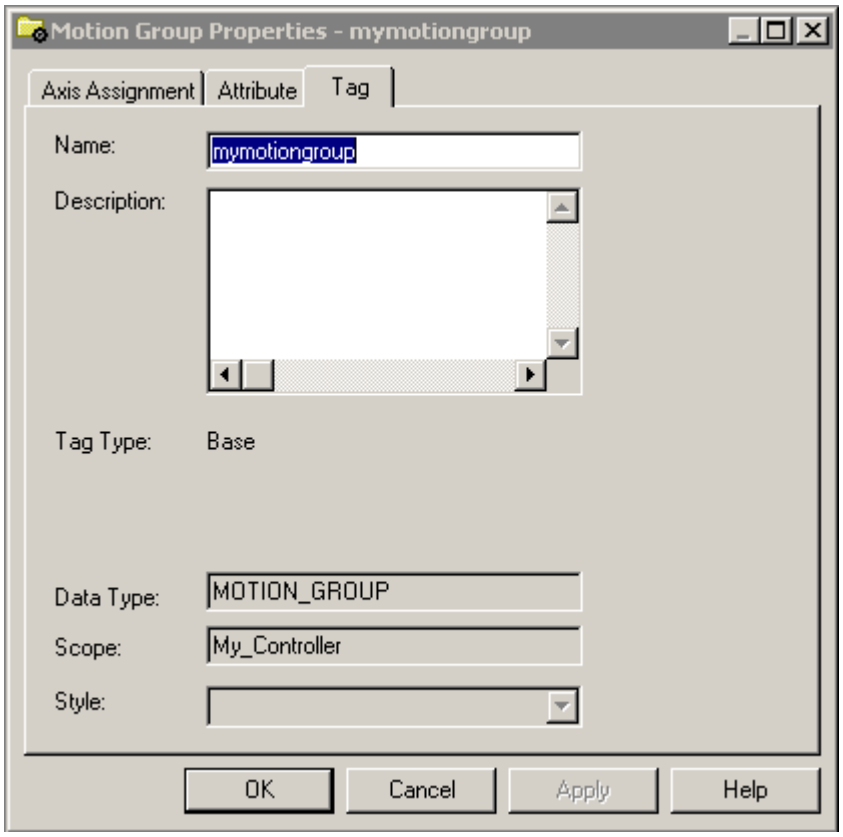


Figure 5.7 Motion Group Properties - Tag Tab

When you are online, all of the parameters on this tab transition to a read-only state, and cannot be modified. If you go online before you save your changes, all pending changes revert to their previously-saved state.

Name

Enter the name of the motion group. This name must not exceed 40 characters. If you enter more than 40 characters, the system notifies you and it ignores the extra characters.

Description

Enter a description of the motion group. This description must not exceed 128 characters. If you enter more than 128 characters, the system notifies you and it ignores the extra characters.

Tag Type (read-only)

Displays the type of tag.

- Base - a normal tag
- Alias - a tag that references another tag with the same definition

Data Type (read-only)

The axis data type: MOTION_GROUP

Scope

Displays the scope of the current tag. The scope is either controller scope, or program scope, based on one of the existing programs in the controller.

Style

Not applicable to motion group tags.

Produce this tag for up to

A checked box indicates that this tag is available to remote controllers through controller-to-controller messaging. If this box is checked, the system displays the maximum number of consumers (i.e., connections) allowed for this tag.

The default number of consumers is 2.

Base Tag

If this tag is an alias, this field displays the name of the motion group tag on which this alias was based. The base tag actually defines the memory where the data element is stored.

Naming and Configuring Your Motion Axis

This chapter describes how to name, configure, and edit your axis properties. Be careful while reading this information. Many of the screens appear to be the same (and many are) but some of the screens change in content based on the type of axis. They are labeled where different, so read through the entire section to make sure you find the correct explanation for the type of axis selected.

Naming an Axis

Naming an axis adds it to your application. To name an axis:

Go to the **File** pull-down menu, select **New Component**, and then select **Tag**.

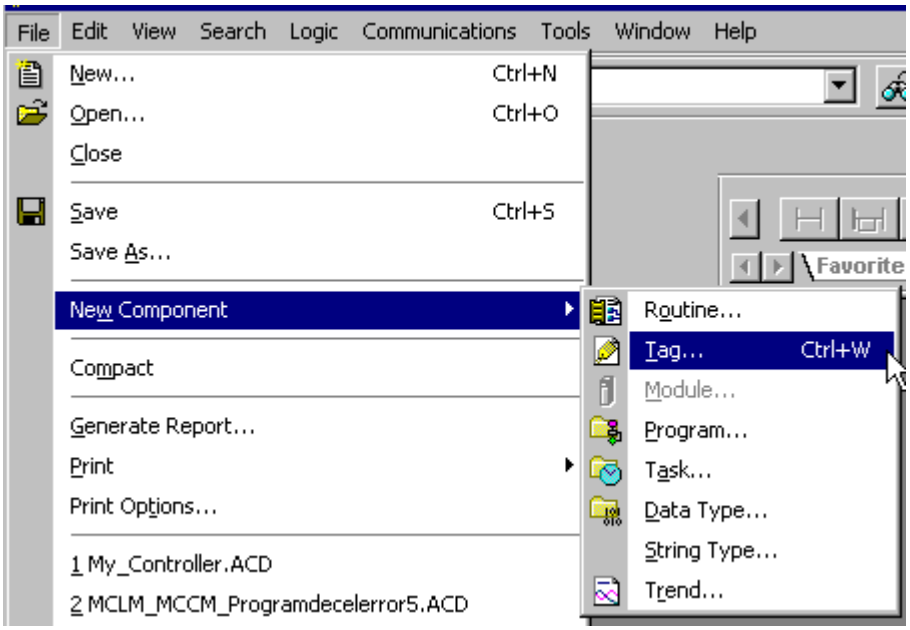


Figure 6.1 File Menu to New Component to Tag

You can also right click on the Motion Group and select New Axis and the type of axis tag you want to create from the menu.

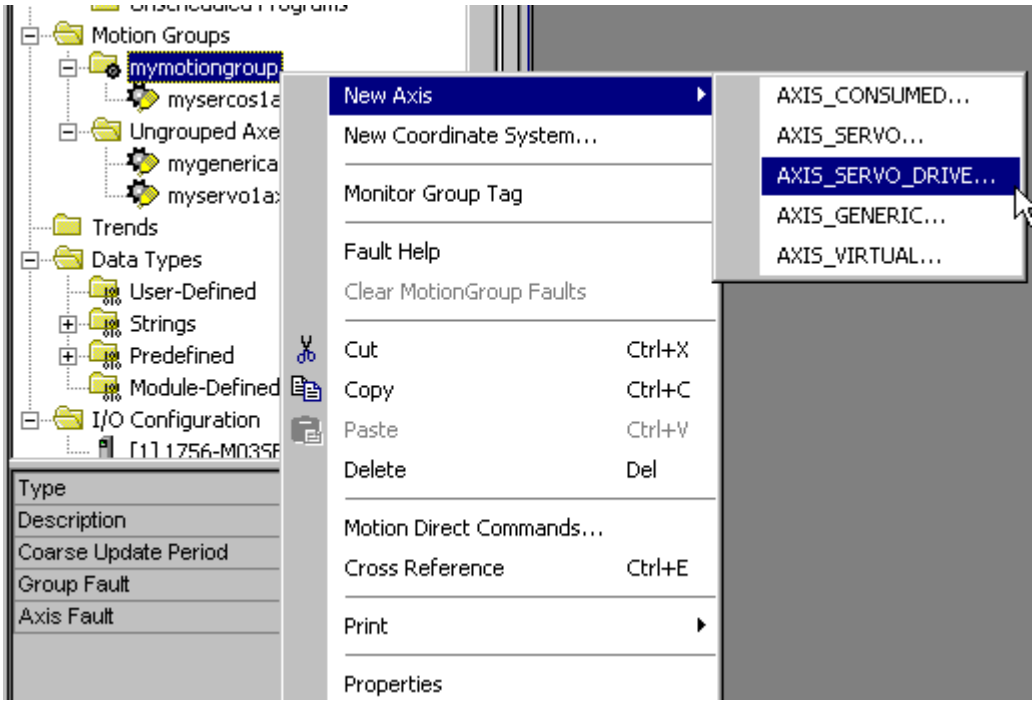


Figure 6.2 Naming an Axis From Motion Group

You can also initiate a new axis by right clicking on Ungroup Axes and selecting the type of axis you want to create.

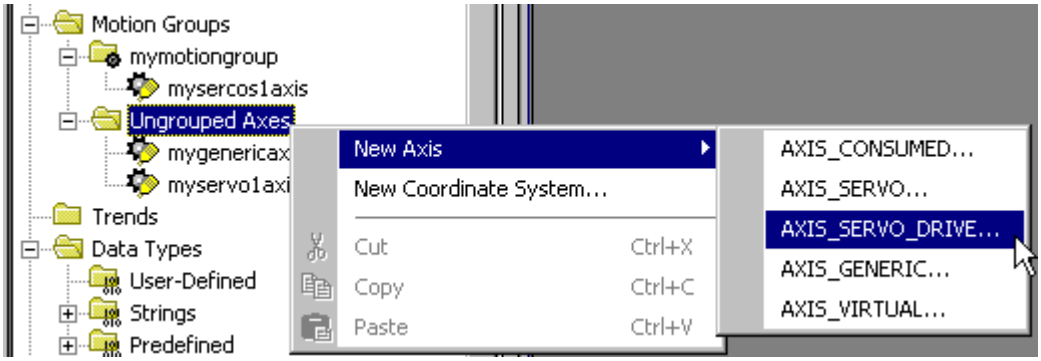


Figure 6.3 Naming an Axis From Ungrouped Axes

The New Tag window appears.

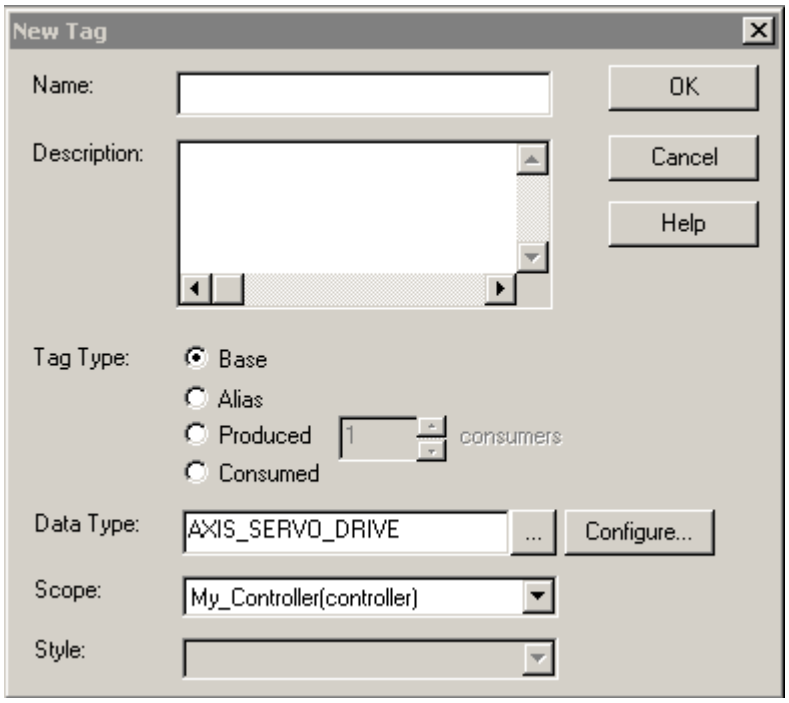


Figure 6.4 New Tag Dialog

If you accessed the New Tag window from either Motion Group or Ungrouped Axes, the Data Type is already filled in.

Entering Tag Information

A tag allows you to allocate and reference data stored in the controller. A tag can be a simple, single element, or an array, or a structure. There are four types of tags that you can create:

- A base tag allows you to create your own internal data storage.
- An alias tag allows you to assign your own name to an existing tag, structure tag member, or bit.
- A produced tag lets you make the tag available to remote controllers through controller-to-controller messaging.
- A consumed tag allows you to retrieve data from a tag in another controller.

You must set up only one consumed tag to get data from the same producing tag in another controller.

ATTENTION

Setting up more than one consumed tag results in unpredictable controller to controller behavior.

Use this dialog to create new tags. The parameters that appear on this dialog depend upon the type of tag you are creating.

You can create base tags and alias tags while the controller is online or offline, as long as the new tag is verified. You can only create consumed tags while the controller is offline.

Common Parameters

The following parameters appear on the New Tag dialog whether you are creating a base tag, alias tag, or consumed tag.

Name

Enter the name of the tag you want to create.

Description

Enter a description of the tag.

Tag Type

Check the type of tag you are creating:

- Base – refers to a normal tag (selected by default)
- Alias – refers to a tag, which references another tag with the same definition. Special parameters appear on the New Tag dialog that allow you to identify to which base tag the alias refers.
- Produced – refers to a tag that has been made available to other controllers. If this type is chosen, then you can set the maximum number of consumers allowed for this tag.
- Consumed (only available when the controller is offline) – refers to a tag that is produced by another controller whose data you want to use in this controller. Special parameters appear on the New Tag dialog that allow you to identify from where the consumed tag is to come.

Data Type

In the Data Type field you can either enter the type of tag you want to create directly or click on the ellipsis button to go to the Select Data Type dialog. From this dialog you can select the appropriate axis data type: AXIS_CONSUMED, AXIS_SERVO, AXIS_SERVO_DRIVE, AXIS_GENERIC, or AXIS_VIRTUAL.

Make entries in the following fields.

Field	Entry	
Name	Type a name for the servo axis. The name can: have a maximum of 40 characters contain letters, numbers and underscores (_).	
Description	Type a description for your motion axis. This field is optional.	
Data type	AXIS_CONSUMED AXIS_SERVO AXIS_SERVO_DRIVE, AXIS_GENERIC AXIS_VIRTUAL	
Scope	Select the scope of the axis variable.	
	To use the axis	**Select**
	Within the entire program	Controller

Editing Motion Axis Properties

Once you have named your axis in the New Tag window, you must then configure it. You can make your configuring options in the Axis Properties screen. These have a series of Tabs that access a specific dialog for configuring the axis. Make the appropriate entries for each of the fields. An asterisk appears on the Tab to indicate changes have been made but not implemented. Press the Apply button at the bottom of each dialog to implement your selections.

TIP When you configure your axis, some fields may be unavailable (greyed-out) because of choices you made in the New Tag window.

In the Controller Organizer, right click on the axis to edit and select Axis Properties from the drop down menu.

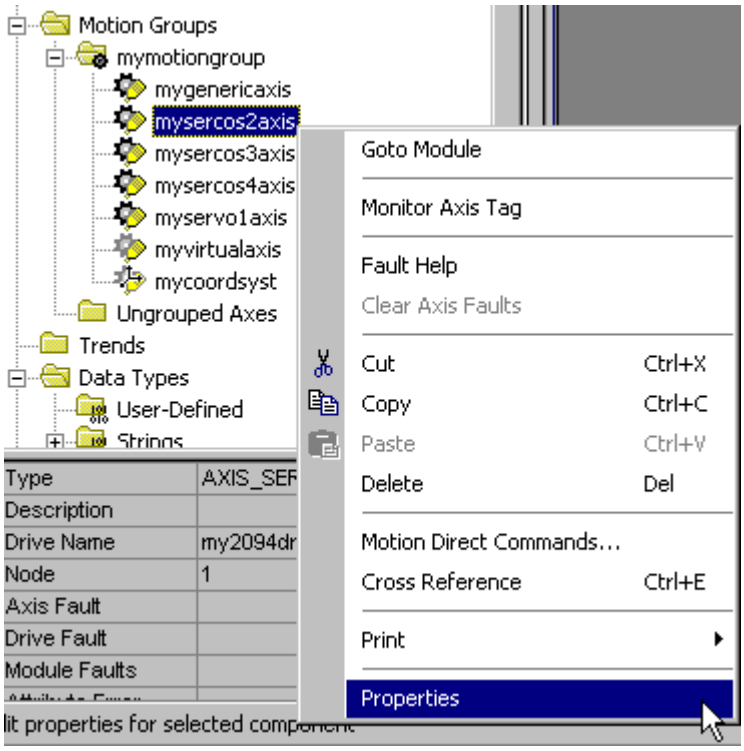


Figure 6.5 Axis Properties Access

The Axis Properties General window appears. The General screen depicted below is for an AXIS_SERVO data type.

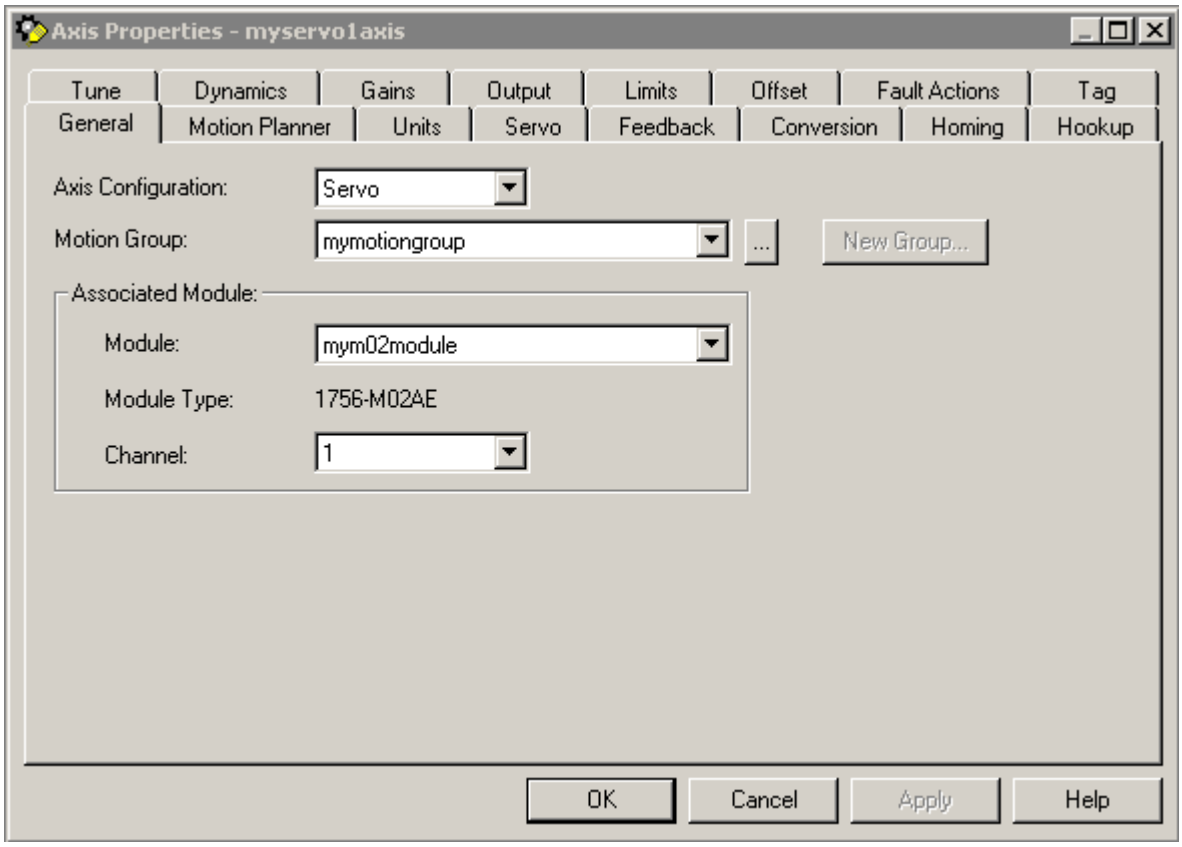


Figure 6.6 Axis Properties - General Tab for Axis_Servo

General Tab – AXIS_SERVO

Use this tab to do the following for an axis, of the data type AXIS_SERVO:

- Configure the axis for Servo operation, or for position Feedback Only.
- Assign the axis, or terminate the assignment of an axis, to a Motion Group.
- Associate the axis with a 1756-M02AE motion module.
- Select the channel, 0 or 1, on the 1756-M02AE motion module to which the axis is connected.

  Note: RSLogix 5000 supports only one Motion Group tag per controller.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Axis Configuration

Selects and displays the intended use of the axis:

- Feedback Only: If the axis is to be used only to display position information from the feedback interface. This selection minimizes the display of axis properties tabs and parameters. The Tabs for Servo, Tune, Dynamics, Gains, Output, Limits, and Offset are not displayed.
- Servo: If the axis is to be used for full servo operation. This selection maximizes the display of axis properties tabs and parameters.

Motion Group

Selects and displays the Motion Group to which the axis is associated. An axis assigned to a Motion Group appears in the Motion Groups branch of the Controller Organizer, under the selected Motion Group sub-branch. Selecting <none> terminates the Motion Group association, and moves the axis to the Ungrouped Axes sub-branch of the Motions Groups branch.

Ellipsis (…) button

Opens the Motion Group Properties dialog box for the Motion Group, where you can edit the properties of the Motion Group. If no Motion Group is assigned to this axis, this button is disabled.

New Group button

Opens the New Tag dialog box, where you can create a new Motion Group tag. This button is enabled only if no Motion Group tag has been created.

Module

Selects and displays the name of the motion module to which the axis is associated. Displays <none> if the axis is not associated with any motion module.

Module Type

This read-only field displays the type of motion module, if any, with which the axis is associated. An axis of the AXIS_SERVO data type can be associated only with 1756-M02AE motion modules. Displays <none> if the axis is not associated with any motion module.

Channel

Selects and displays the 1756-M02AE motion module channel - either 0 or 1 - to which the axis is assigned. Disabled when the axis is not associated with any motion module.

General Tab - AXIS_SERVO_DRIVE

The General screen shown below is for an AXIS_SERVO DRIVE Data Type.

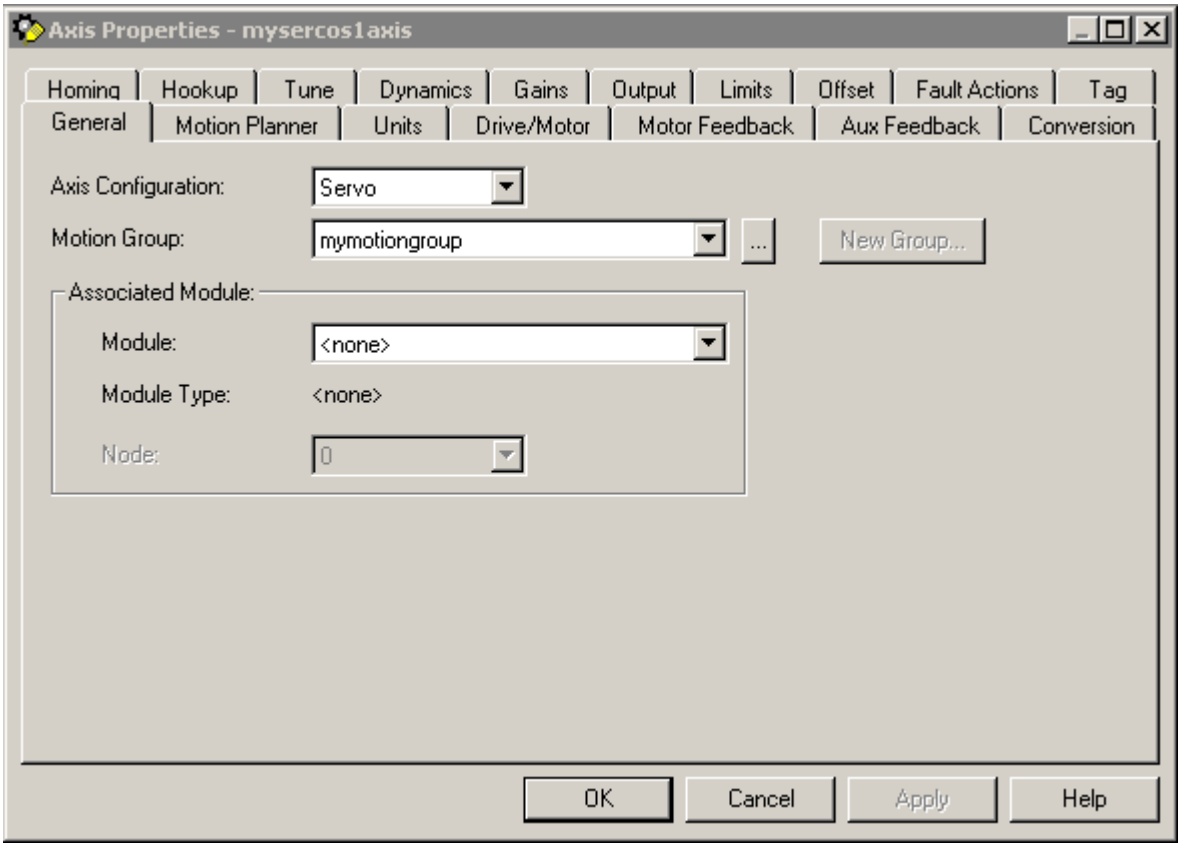


Figure 6.7 Axis Properties - General Tab for Axis_Servo_Drive

Use this tab to do the following for an axis, of the data type AXIS_SERVO_DRIVE:

- Configure the axis for Servo operation, or for position Feedback Only.

- Assign the axis, or terminate the assignment of an axis, to a Motion Group.
- Associate the axis with a SERCOS Drive.
- View the base node of the associated 1756- M*xx*SE motion module.

  Note: RSLogix 5000 supports only one Motion Group tag per controller.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Axis Configuration

Selects and displays the intended use of the axis:

- Feedback Only: If the axis is to be used only to display position information from the feedback interface. This selection minimizes the display of axis properties tabs and parameters. The Tabs for Tune, Dynamics, Gains, Output, Limits, and Offset are not displayed.
- Servo: If the axis is to be used for full servo operation. This selection maximizes the display of axis properties tabs and parameters.

Motion Group

Selects and displays the Motion Group to which the axis is associated. An axis assigned to a Motion Group appears in the Motion Groups branch of the Controller Organizer, under the selected Motion Group sub-branch. Selecting <none> terminates the Motion Group association, and moves the axis to the Ungrouped Axes sub-branch of the Motions Groups branch.

Ellipsis (…) button

Opens the Motion Group Properties dialog box for the Motion Group, where you can edit the properties of the Motion Group. If no Motion Group is assigned to this axis, this button is disabled.

New Group button

Opens the New Tag dialog box, where you can create a new Motion Group tag. This button is enabled only if no Motion Group tag has been created.

Module

Selects and displays the name of the SERCOS drive to which the axis is associated. Displays <none> if the axis is not associated with any drive.

Module Type

This read-only field displays the type of SERCOS drive, if any, with which the axis is associated. An axis of the AXIS_SERVO_DRIVE data type can be associated only with 1756- M*xx*SE motion modules. Displays <none> if the axis is not associated with any drive.

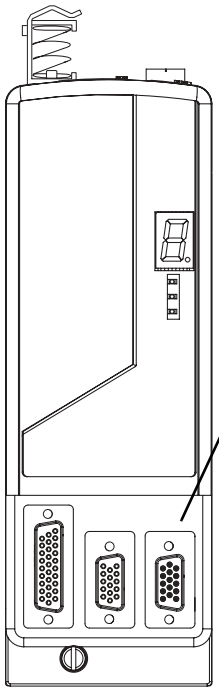
Node

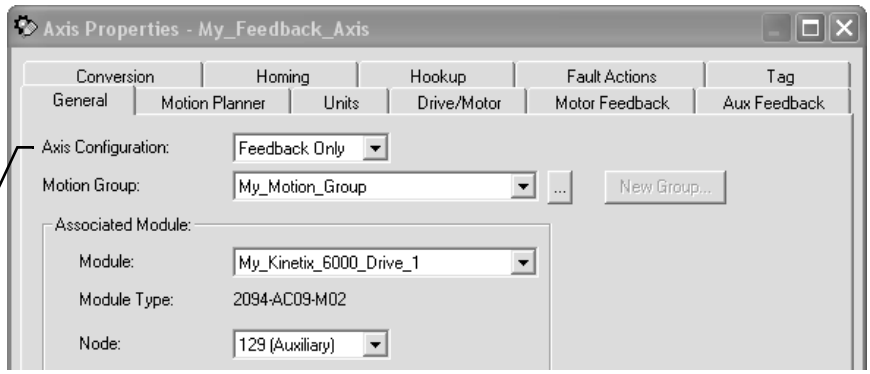
Displays the base node of the associated SERCOS drive. Disabled when the axis is not associated with any drive.

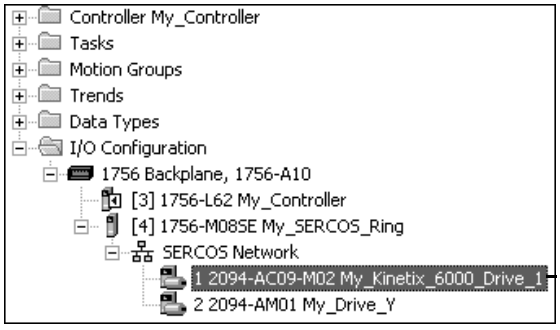
Node with a Kinetix 6000 Drive

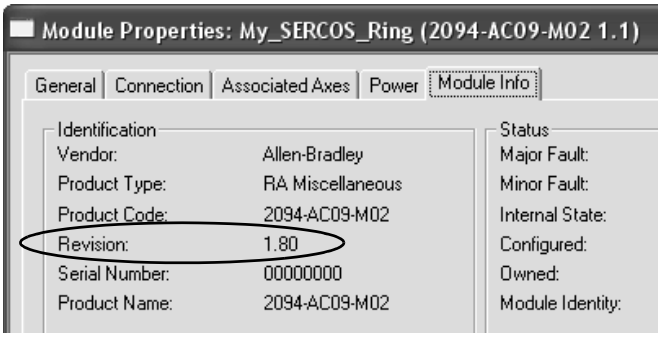
IMPORTANT Do you want to use the auxiliary feedback port of a Kinetix 6000 drive as a feedback-only axis?

If YES, then make sure the drive has firmware revision 1.80 or later.









When a Kinetix 6000 drive is designated in the Associated Module box, there is an additional option for the Node value. It is the node associated with the drive plus 128 with (Auxiliary) after the number. The range is 129 to 234. When the Auxiliary Node assignment is

chosen the axis configuration is changed to Feedback Only on the General Tab and the spat (*) appears next to General.

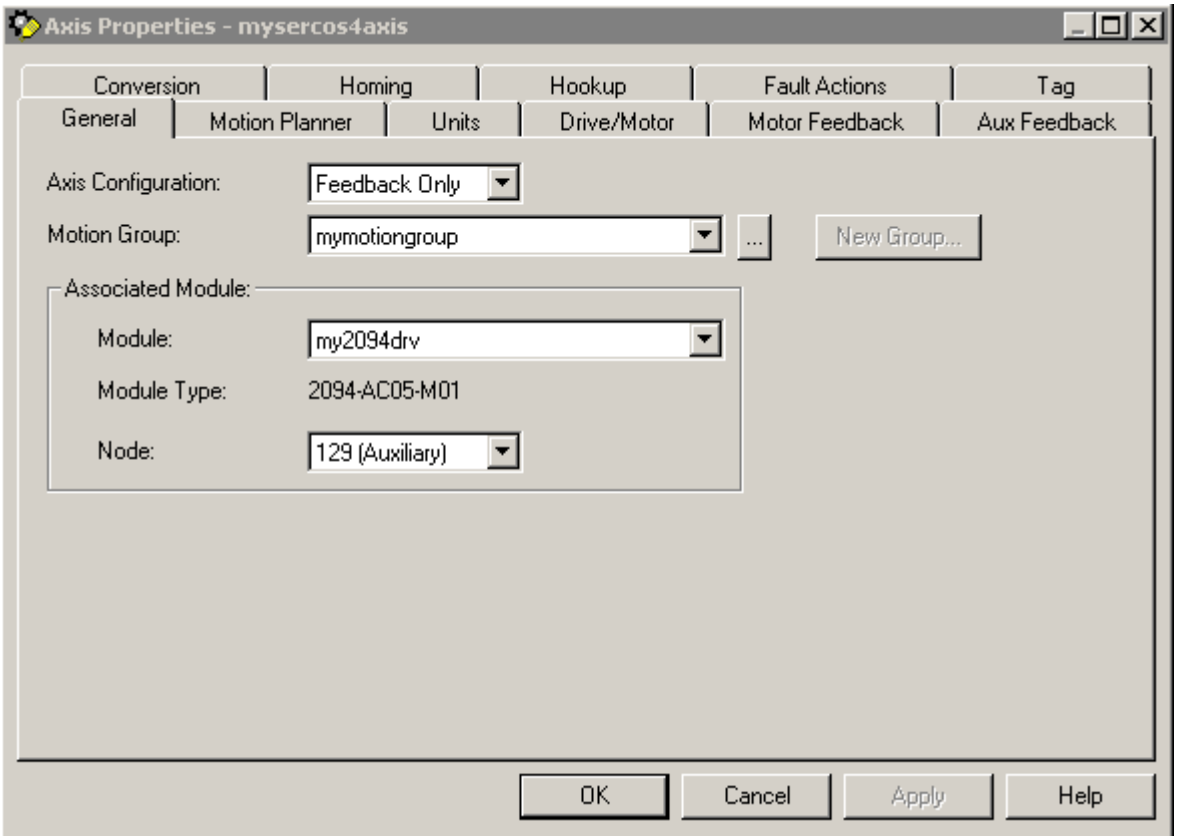


Figure 6.8 General Tab with a Kinetix 6000 Drive and Node set to Auxiliary

This also places a spat (*) on the Aux Feedback Tab and you must go there and select the appropriate values. On the Drive/Motor Tab the Loop Configuration is changed to Aux Feedback Only.

General Tab - AXIS_VIRTUAL The AXIS_VIRTUAL General Tab is shown below.

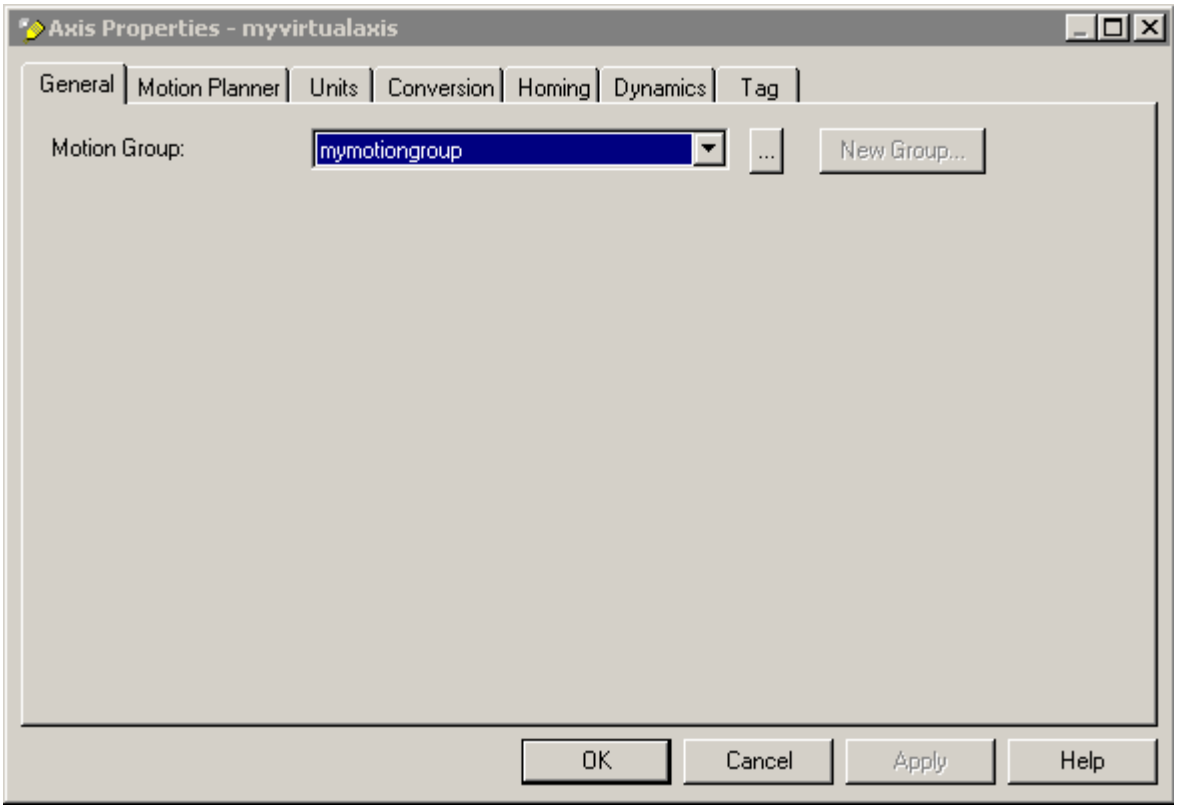


Figure 6.9 Axis Properties - General Tab for Axis_Virtual

Use this tab to associate the axis, of the data type AXIS_VIRTUAL, to a Motion Group.

Note: RSLogix 5000 supports only one Motion Group tag per controller.

When RSLogix 5000 software is online, the parameters on this tab transition to a read-only state. When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Motion Group

Selects and displays the Motion Group to which the axis is associated. An axis assigned to a Motion Group appears in the Motion Groups

branch of the Controller Organizer, under the selected Motion Group sub-branch. Selecting <none> terminates the Motion Group association, and moves the axis to the Ungrouped Axes sub-branch of the Motions Groups branch.

Ellipsis (…) button

Opens the Motion Group Properties dialog box for the Motion Group, where you can edit the properties of the Motion Group. If no Motion Group is assigned to this axis, this button is disabled.

New Group button

Opens the New Tag dialog box, where you can create a new Motion Group tag. This button is enabled only if no Motion Group tag has been created.

The AXIS_GENERIC General Tab is shown below.

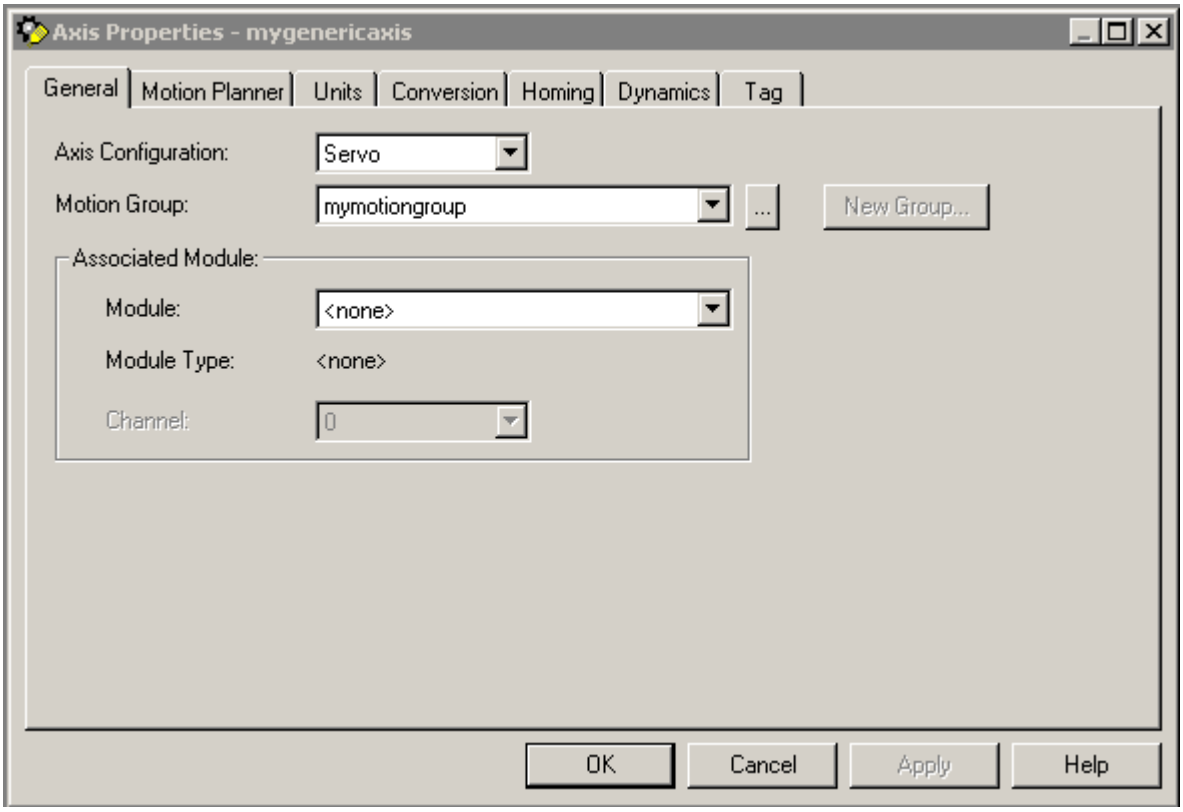


Figure 6.10 Axis Properties - General Tab for AXIS_GENERIC

General Tab – AXIS_GENERIC

Use this tab to do the following for an axis, of the data type AXIS_GENERIC:

- Configure the axis for Servo operation, or for position Feedback Only.
- Assign the axis, or terminate the assignment of an axis, to a Motion Group.
- Associate the axis with a motion module.
- Select the channel, 0 or 1, on the motion module to which the axis is connected.

  Note: RSLogix 5000 supports only one Motion Group tag per controller.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Axis Configuration

Selects and displays the intended use of the axis:

- Feedback Only: If the axis is to be used only to display position information from the feedback interface. This selection minimizes the display of axis properties tabs and parameters. The Tab for Dynamics is not available.
- Servo: If the axis is to be used for full servo operation. This selection maximizes the display of axis properties tabs and parameters.

Motion Group

Selects and displays the Motion Group to which the axis is associated. An axis assigned to a Motion Group appears in the Motion Groups branch of the Controller Organizer, under the selected Motion Group sub-branch. Selecting <none> terminates the Motion Group association, and moves the axis to the Ungrouped Axes sub-branch of the Motions Groups branch.

Ellipsis (…) button

Opens the Motion Group Properties dialog box for the Motion Group, where you can edit the properties of the Motion Group. If no Motion Group is assigned to this axis, this button is disabled.

New Group button

Opens the New Tag dialog box, where you can create a new Motion Group tag. This button is enabled only if no Motion Group tag has been created.

Module

Selects and displays the name of the motion module to which the axis is associated. Displays <none> if the axis is not associated with any motion module.

Module Type

This read-only field displays the type of motion module, if any, with which the axis is associated. Displays <none> if the axis is not associated with any motion module.

Channel

Selects and displays the motion module channel - either 0 or 1 - to which the axis is assigned. Disabled when the axis is not associated with any motion module.

Press **Apply** to accept your edits.

Select the Motion Planner tab to access the Axis Properties Motion Planner dialog.

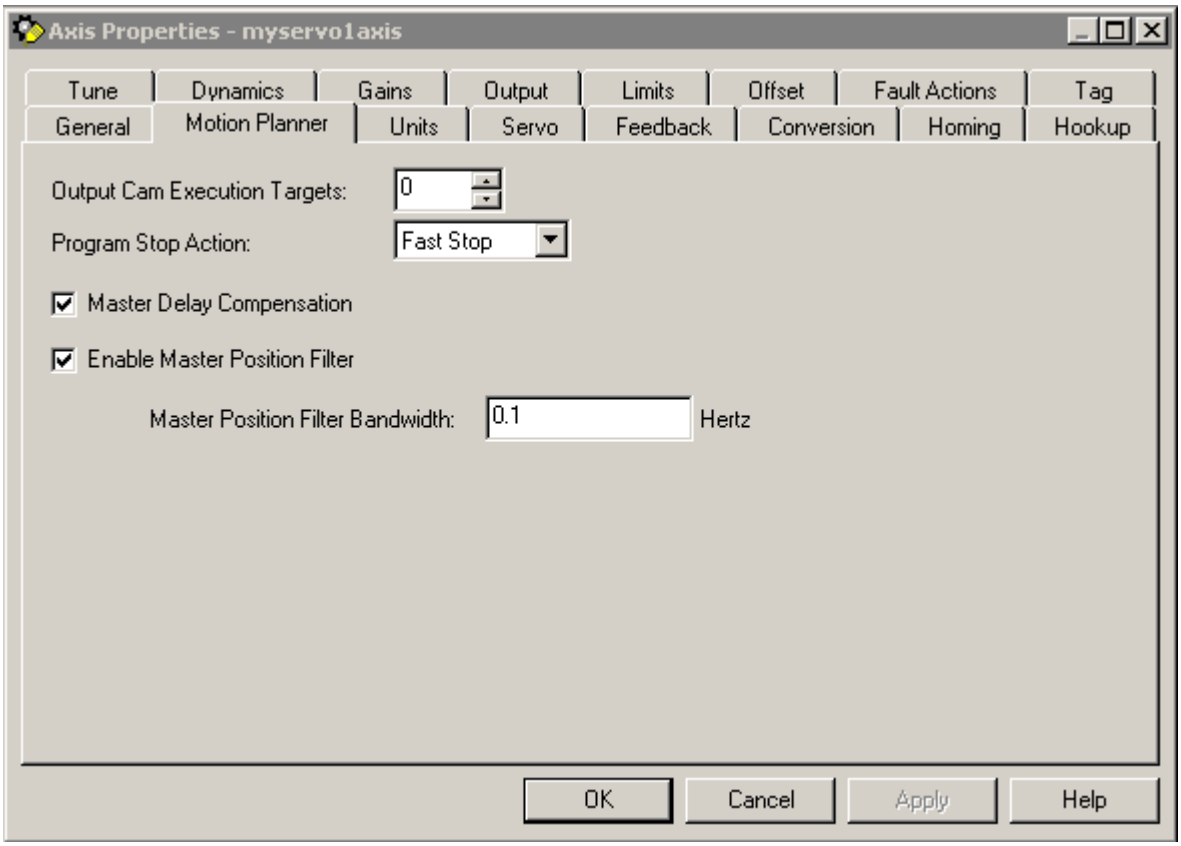


Figure 6.11 Axis Properties – Motion Planner Tab

Motion Planner Tab

The Motion Planner Tab is where you set/edit the number of Output Cam execution targets, the type of stop action to use, enable or disable Master Delay Compensation, enable or disable Master Position Filter, and set the bandwidth for Master Position Filter Bandwidth. The Motion Planner tab has the same fields regardless of the type of axis.

Output Cam Execution Targets

Determines how many Output Cam execution nodes (instances) are created for a specific axis. Note that the Execution Target parameter for the MAOC/MDOC instructions specify which of the configured execution nodes the instruction is affecting. In addition, the number specified in the Axis Properties dialog specifies the number of instances of Output Cam in which the value of zero means “none”, and the value specified for Execution Target in the MAOC instruction references a specific instance in which a value of zero selects the first instance.

Program Stop Action

Select how a specific axis is stopped when the processor undergoes a mode change, or when an explicit Motion Group Programmed Stop (MGPS) instruction is executed:

- **Fast Disable:** The axis is decelerated to a stop using the current configured value for maximum deceleration. Servo action is maintained until the axis motion has stopped at which time the axis is disabled (i.e., Drive Enable is disabled, and Servo Action is disabled).

- **Fast Shutdown:** The axis is decelerated to a stop using the current configured value for maximum deceleration. Once the axis motion is stopped, the axis is placed in the shutdown state (i.e., Drive Enable is disabled, Servo Action is disabled, and the OK contact is opened). To recover from this state, a reset instruction must be executed.

- **Fast Stop:** The axis is decelerated to a stop using the current configured value for maximum deceleration. Servo action is maintained after the axis motion has stopped. This mode is useful for gravity or loaded systems, where servo control is needed at all times.

- **Hard Disable:** The axis is immediately disabled (i.e. Drive Enable is disabled, Servo Action is disabled, but the OK contact is left closed). Unless the drive is configured to provide some form of dynamic breaking, this results in the axis coasting to a stop.

- **Hard Shutdown:** The axis is immediately placed in the shutdown state. Unless the drive is configured to provide some form of dynamic breaking, this results in the axis coasting to a stop. To recover from this state, a reset instruction must be executed.

Master Delay Compensation Checkbox

Use this checkbox to Enable/Disable Master Delay Compensation. Master Delay Compensation is used balance the delay time between reading the master axis command position and applying the associated slave command position to the slave's servo loop. This feature ensures that the slave axis command position accurately tracks the actual position of the master axis i.e. zero tracking error.

Clicking on this box enables Master Delay Compensation. The default setting is Disabled.

If the axis is configured for Feedback only, Master Delay Compensation should be disabled.

Enable Master Position Filter Checkbox

Use this checkbox to Enable/Disable Master Position Filter. The default is disabled and must be checked to enable position filtering. Master Position Filter, when enabled, effectively filters the specified master axis position input to the slave axis's gearing or position camming operation. The filter smoothes out the actual position signal from the master axis, and thus smoothes out the corresponding motion of the slave axis.

When this feature is enabled the Master Position Filter Bandwidth field is enabled.

Master Position Filter Bandwidth

The Master Position Filter Bandwidth field is enabled when the Enable Position Filter checkbox is selected. This field controls the bandwidth for master position filtering. Enter a value in Hz in this field to set the bandwidth to for the Master Position Filter.

IMPORTANT A value of zero for Master Position Filter Bandwidth effectively disables the master position filtering.

Press **Apply** to accept your edits.

Select the Units tab to access the Axis Properties Units dialog.

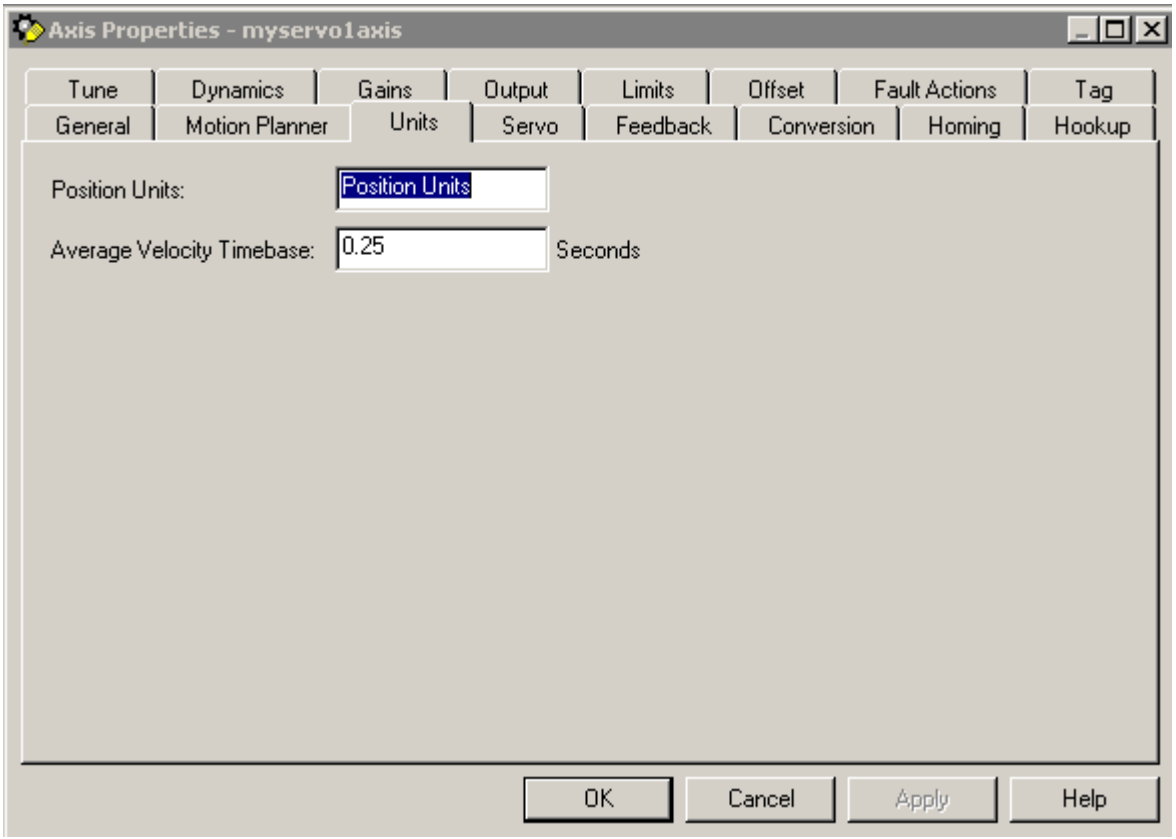


Figure 6.12 Axis Properties - Units Tab

Units Tab

The Units Tab is the same for all axis data types. Use this tab to determine the units to define your motion axis.

When RSLogix 5000 software is online and the controller transitions to hard run, or the servo loop is on (i.e., active), then all the attributes on this tab transition to a read only state. When any attribute transitions to a read only state, then any pending attribute changes are reverted.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Position Units

User-defined engineering units (rather than feedback counts) used for labeling all motion-related values (e.g., position, velocity, etc.) These position units can be different for each axis.

Note: Position Units should be chosen for maximum ease of use in your application. For example, linear axes might use position units of Inches, Meters, or mm whereas rotary axes might use units of Revs or Degrees.

Average Velocity Timebase

Specifies the time (in seconds) to be used for calculating the average velocity of the axis. This value is computed by taking the total distance the axis travels in the amount of time specified, and dividing this value by the timebase.

The average velocity timebase value should be large enough to filter out the small changes in velocity that would result in a "noisy" velocity value, but small enough to track significant changes in axis velocity. A value of 0.25 to 0.50 seconds should work well for most applications.

Click on the Apply button to accept your changes.

Servo Tab - AXIS_SERVO

Click on the Servo Tab from the Axis Properties for AXIS_SERVO to access the Servo dialog.

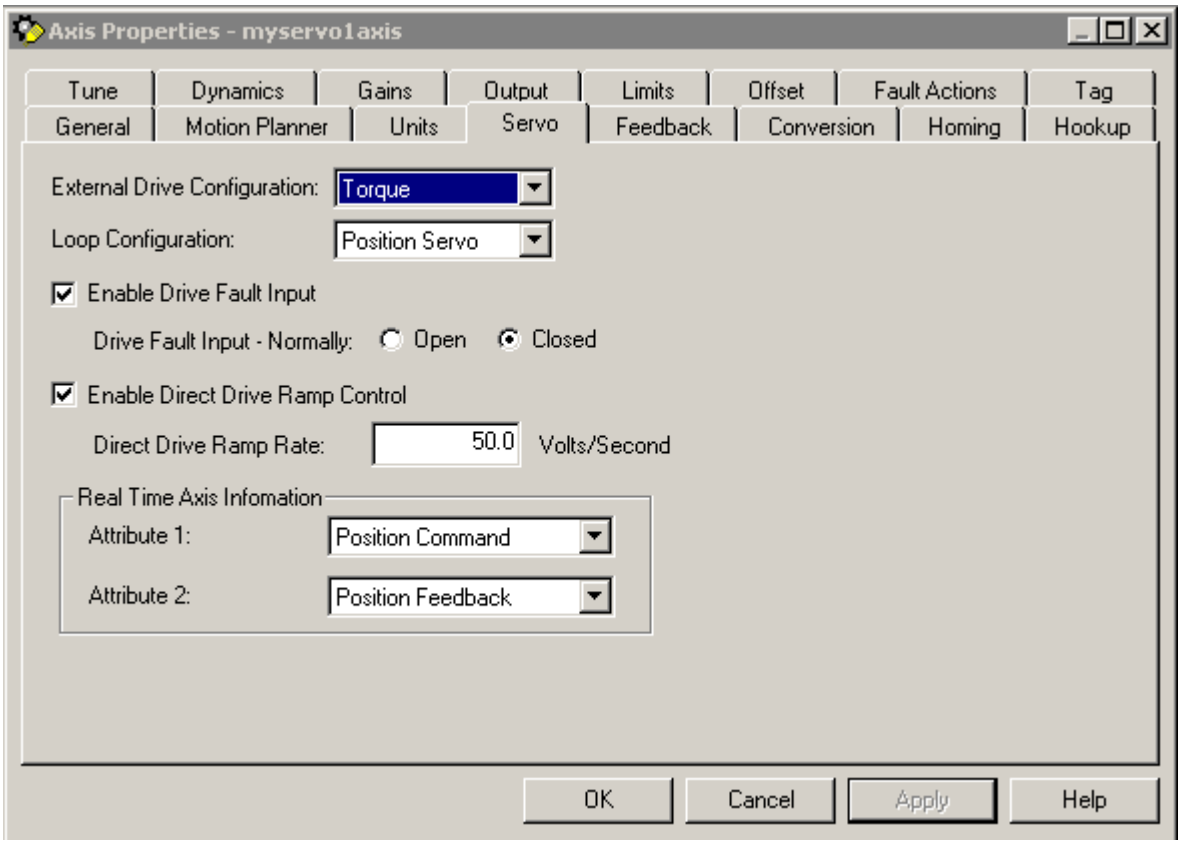


Figure 6.13 Axis Properties - Servo Tab for Axis_Servo

For an axis of the data type AXIS_SERVO, configured for Servo operation in the General tab of this dialog box, use the SERVO tab to:

- configure an external drive
- configure the drive fault input
- select up to two axis attributes whose status can be monitored

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

External Drive Configuration

Select the drive type for the servo loop:

- Velocity - disables the servo module's internal digital velocity loop.
- Torque - the servo module's internal digital velocity loop is active, which is the required configuration for interfacing the servo axis to a torque loop servo drive.
- Hydraulic - enables features specific to hydraulic servo applications.

Loop Configuration

Select the configuration of the servo loop. For this release, only Position Servo is available.

Enable Drive Fault Input

Check this box if you wish to enable the Drive Fault Input. When active the motion module receives notice whenever the external drive detects a fault.

Drive Fault Input

Specifies the usual state of the drive fault input when a fault is detected on the drive.

- Normally Open – when a drive fault is detected it opens its drive fault output contacts.
- Normally Closed – when a drive fault is detected it closes its drive fault output contacts.

Enable Direct Drive Ramp Control

Clicking on the Enable Direct drive Ramp Control check box lets you set the Direct Drive Ramp Rate in volts per second for when an MDO instruction is executed.

Direct Drive Ramp Rate

The Direct Drive Ramp Rate is a slew rate for changing the output voltage when a Direct Drive On (MDO) instruction is executed. A Direct Drive Ramp Rate of 0 disables the output rate limiter letting the Direct Drive On voltage to be applied directly.

Real Time Axis Information

Attribute 1/Attribute 2

Select up to two axis attributes whose status are transmitted – along with the actual position data – to the Logix processor. The values of the selected attributes can be accessed via the standard GSV or Get Attribute List service.

> **Note:** The servo status data update time is precisely the coarse update period.

If a GSV is done to one of these servo status attributes without having selected this attribute via the Drive Info Select attribute, the attribute value is static and does not reflect the true value in the servo module.

Click on the Apply button to accept your changes.

Feedback Tab – (AXIS_SERVO)

The Feedback Tab allows you to select the type of Feedback used with your Servo axis.

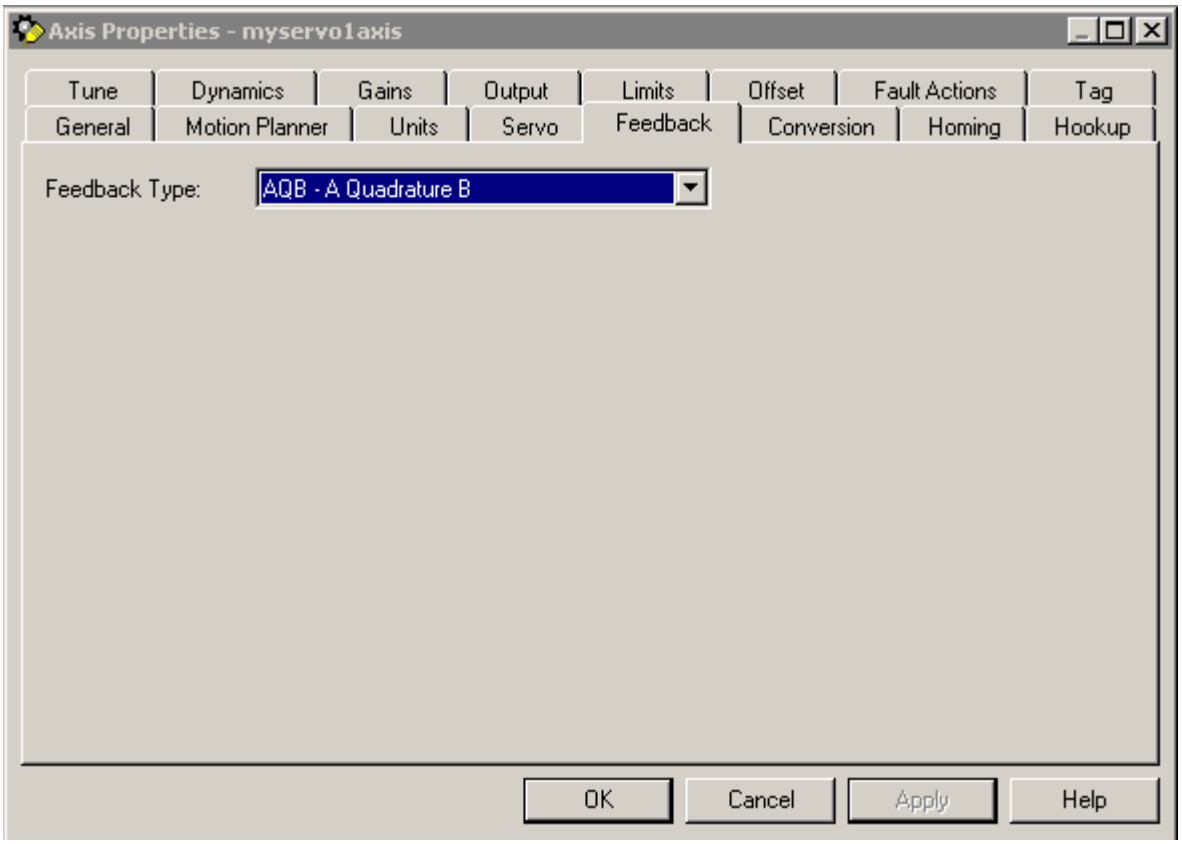


Figure 6.14 Axis Properties - Feedback Tab for Axis_Servo

Feedback Type

Select the appropriate Feedback for your current configuration. Your options are dependent upon the motion module to which the axis is associated.

A Quadrature B Encoder Interface (AQB)

The 1756-M02AE servo module provides interface hardware to support incremental quadrature encoders equipped with standard 5-Volt differential encoder interface signals. The AQB option has no associated attributes to configure.

Synchronous Serial Interface (SSI)

The 1756-M02AS servo module provides an interface to transducers with Synchronous Serial Interface (SSI) outputs. SSI outputs use standard 5V differential signals (RS422) to transmit information from the transducer to the controller. The signals consist of a Clock generated by the controller and Data generated by the transducer.

Linear Displacement Transducer (LDT)

The 1756-HYD02 Servo module provides an interface to the Linear Magnetostrictive Displacement Transducer, or LDT. A Field Programmable Gate Array (FPGA) is used to implement a multi-channel LDT Interface. Each channel is functionally equivalent and is capable of interfacing to an LDT device with a maximum count of 240,000. The LDT interface has transducer failure detection and digital filtering to reduce electrical noise.

The Feedback screen changes in appearance depending on the selected Feedback Type.

When the servo axis is associated with a 1756-M02AS motion module the only Feedback Type available is SSI-Synchronous Serial Interface and the Feedback Tab screen looks like the following illustration.

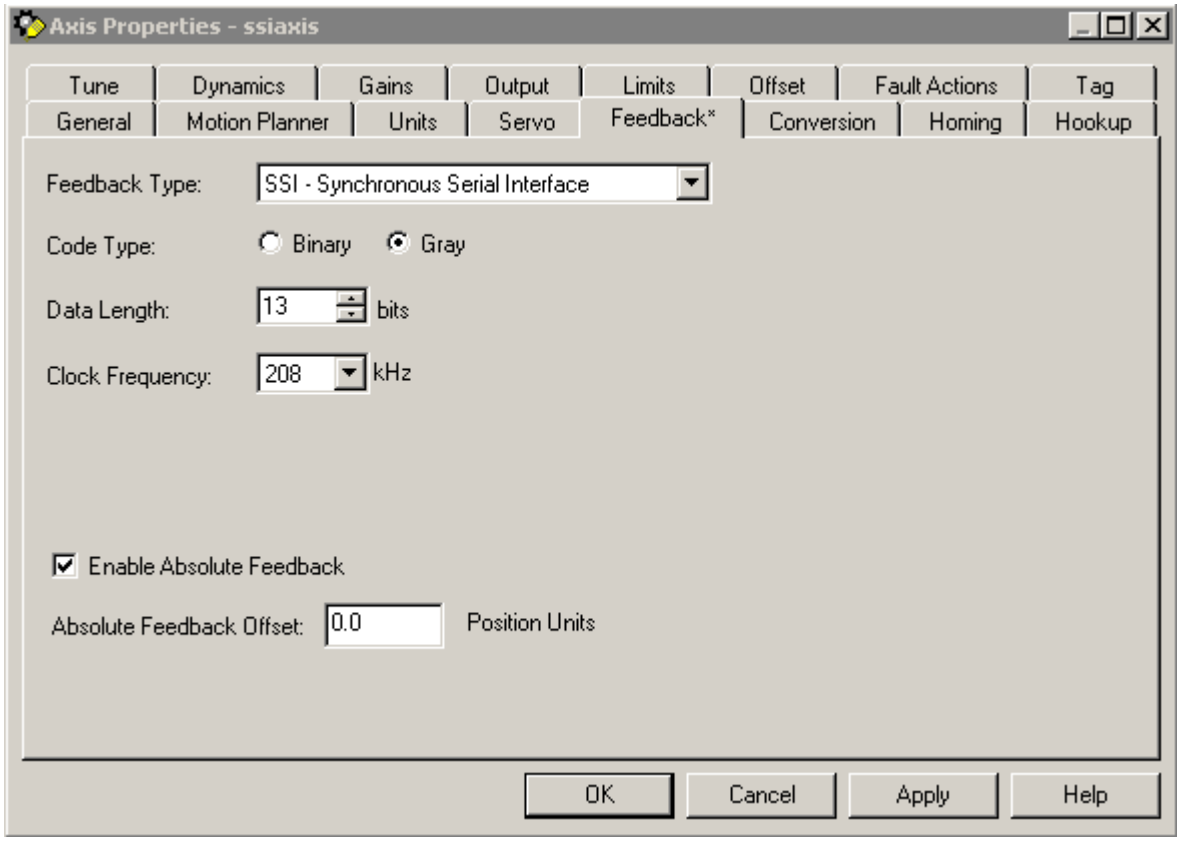


Figure 6.15 Servo Feedback Tab for 1756-M02AS

Code Type

The type of code, either Binary or Gray, used to report SSI output. If the module's setting does not match the feedback device, the positions jump around erratically as the axis moves.

Data Length

The length of output data in a specified number of bits between 8 and 31. The data length for the selected feedback device can be found in its specifications.

Clock Frequency

Sets the clock frequency of the SSI device to either 208 (default) or 625 kHz. When the higher clock frequency is used, the data from the feedback device is more recent, but the length of the cable to the transducer must be shorter than with the lower frequency.

Enable Absolute Feedback

This checkbox allows you to either enable (checked) or disable (unchecked) the Absolute Feedback feature. The default is enabled. If Enable Absolute Feedback is set, the servo module adds the Absolute Feedback Offset to the current position of the feedback device to establish the absolute machine reference position. Absolute feedback devices retain their position reference even through a power-cycle, therefore the machine reference system can be restored at power-up.

Absolute Feedback Offset

If Absolute feedback is enabled, this field becomes active. You can enter the amount of offset, in position units, to be added to the current position of the Feedback device.

The SSI is an absolute feedback device. To establish an appropriate value for the Offset, the MAH instruction can be executed with the Home Mode set to Absolute (the only valid option if Enable Absolute Feedback is enabled). When executed, the module computes the Absolute Feedback Offset as the difference between the configured value for Home Position and the current absolute feedback position of the axis. The computed Absolute Feedback Offset is immediately applied to the axis upon completion of the MAH instruction. The actual position of the axis is re-referenced during execution of the MAH instruction therefore, the servo loop must not be active. If the servo loop is active, the MAH instruction errors.

When the Enable Absolute Feedback is disabled, the servo module ignores the Absolute Feedback Offset and treats the feedback device as an incremental position transducer. A homing or redefine position operation is required to establish the absolute machine reference position. The Absolute Home Mode is invalid.

> **Note:** If using Single-turn or Multi-turn Absolute SSI Feedback transducers, see the Homing Tab information for important

details concerning Absolute feedback tranducer's marker reference.

When the servo axis is associated to a 1756-HYD02 motion module, then LDT - Linear Displacement Transducer is the only option for Feedback Type.

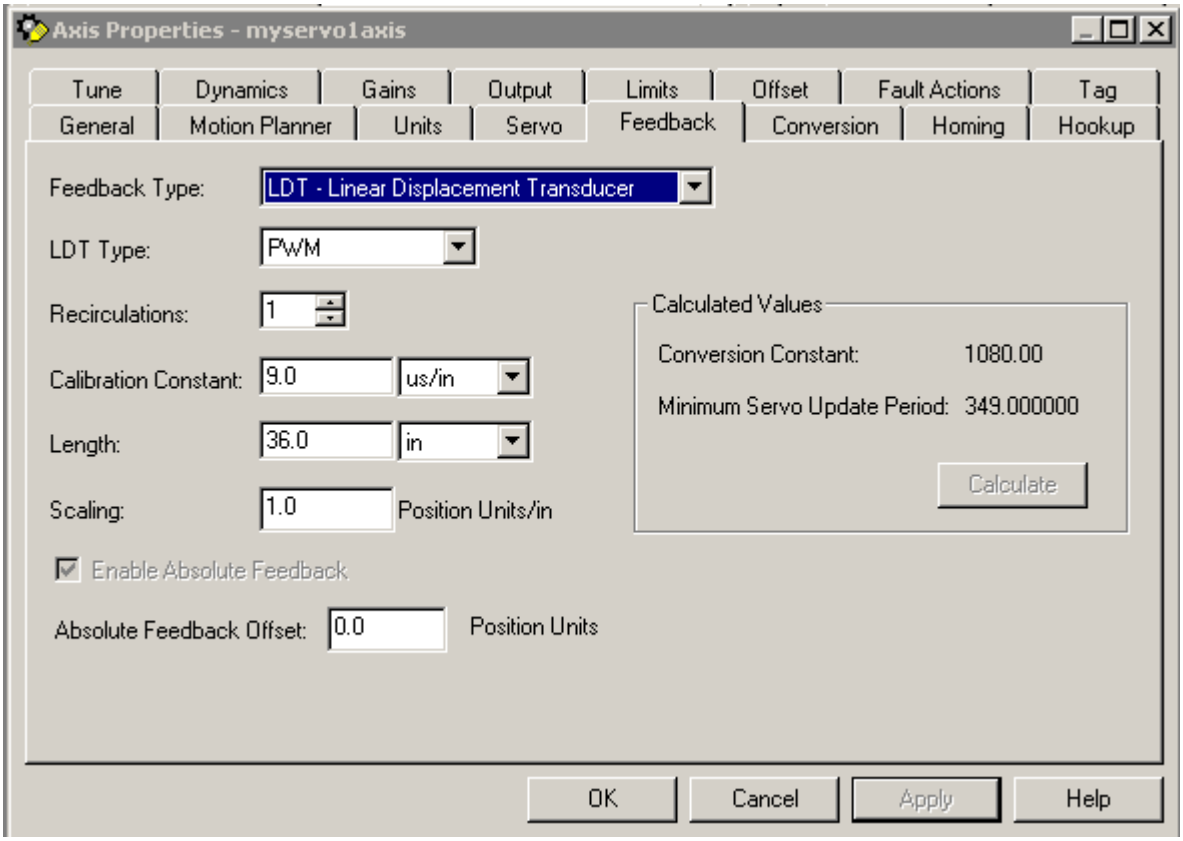


Figure 6.16 Servo Feedback Tab for 1756-HYD02

LDT Type

This field selects the type of LDT to use to provide feedback to the Hydraulic module. The available types are PWM, Start/Stop Rising, or Start/Stop Falling.

Recirculations

Use this field to set the number of repetitions to use to acquire a measurement from an LDT.

Calibration Constant

This is a number that is engraved on the LDT by the manufacturer. It specifies the characteristics of the individual LDT. Each LDT has its own calibration constant therefore, if you change the LDT, you must change the Calibration constant.

Length

This value defines the stroke of travel of the hydraulic cylinder. The length value is used with the number of recirculations to determine the minimum servo update period.

Scaling

Scaling defines the relationship between the LDT unit of measure (length field) and the unit of measure defined at the Units Tab.

Enable Absolute Feedback

This field is grayed out because it is always active when Feedback Type is LDT.

Absolute Feedback Offset

Enter the amount of offset, in position units, to be added to the current position of the LDT.

The LDT is an absolute feedback device. To establish an appropriate value for the Offset, the MAH instruction can be executed with the Home Mode set to Absolute (the only valid option if Enable Absolute Feedback is enabled). When executed, the module computes the Absolute Feedback Offset as the difference between the configured value for Home Position and the current absolute feedback position of the axis. The computed Absolute Feedback Offset is immediately applied to the axis upon completion of the MAH instruction. The actual position of the axis is re-referenced during execution of the MAH instruction therefore, the servo loop must not be active. If the servo loop is active, the MAH instruction errors.

When the Enable Absolute Feedback is disabled, the servo module ignores the Absolute Feedback Offset and treats the feedback device as an incremental position transducer. A homing or redefine position operation is required to establish the absolute machine reference position. The Absolute Home Mode is invalid.

Calculated Values

Conversion Constant

The Conversion Constant is calculated from the values entered on the Feedback screen when the Calculate button is selected. This calculated value must be typed into the Conversion Constant field on the Conversion tab as it is not automatically updated.

Minimum Servo Update Period

The Minimum Servo Update period is calculated based on the values entered for Recirculations and Length on the Feedback Tab. When these values are changed, selecting the Calculate button recalculates the Minimum Servo Update Period based on the new values.

Calculate Button

The Calculate Button becomes active whenever you make changes to the values on the Feedback Tab. Clicking on the Calculate Button recalculates the Conversion Constant and Minimum Servo Update Period values. however, you must then reenter the Conversion Constant value at the Conversion Tab as the values are not updated automatically.

Drive/Motor Tab - (AXIS_SERVO_DRIVE) Use this tab to configure the servo loop for an AXIS_SERVO_DRIVE axis, and open the Change Catalog dialog box.

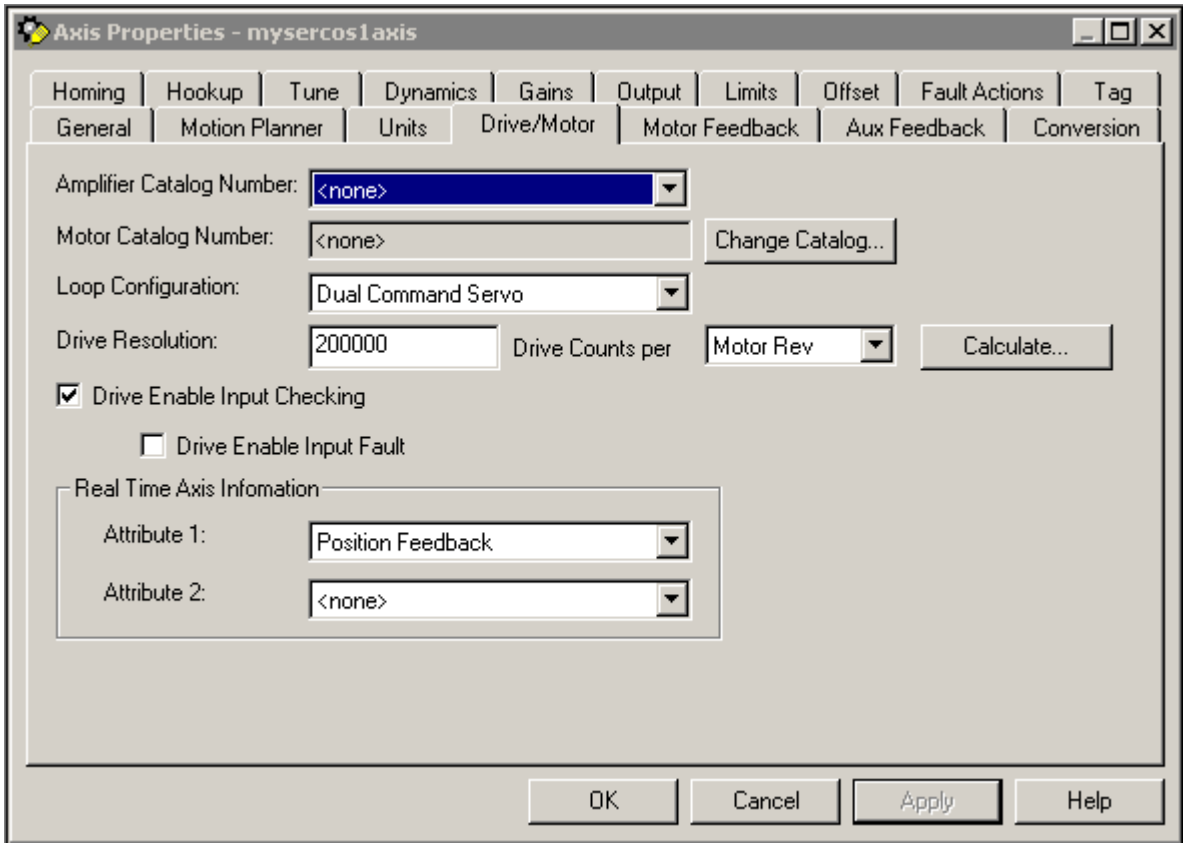


Figure 6.17 Axis Properties - Drive Tab for Axis_Servo_Drive

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

Amplifier Catalog Number

Select the catalog number of the amplifier to which this axis is connected.

Catalog Number

Select the catalog number of the motor associated with this axis. When you change a Motor Catalog Number, the controller recalculates the values of the following values using (among other values) the default Damping Factor of 0.8.

On this tab or dialog:	These attributes are recalculated:
Motor Feedback tab	Motor Feedback Type Motor Feedback Resolution
Gains tab	Position Proportional Gains Velocity Proportional Gains
Dynamics tab	Maximum Velocity Maximum Acceleration Maximum Deceleration
Limits tab	Position Error Tolerance
Custom Stop Action Attributes dialog	Stopping Torque
Custom Limit Attributes dialog	Velocity Limit Bipolar Velocity Limit Positive Velocity Limit Negative Acceleration Limit Bipolar Acceleration Limit Positive Acceleration Limit Negative Torque Limit Bipolar Torque Limit Positive Torque Limit
Tune Bandwidth dialog	Position Loop Bandwidth Velocity Loop Bandwidth

Note: The Associated Module selection (selected on the General tab), determines available catalog numbers.

Loop Configuration

Select the configuration of the servo loop:

- Motor Feedback Only – Displayed when Axis Configuration is Feedback only
- Aux Feedback Only – Displayed when Axis Configuration is Feedback only

- Position Servo
- Aux Position Servo (not applicable to Ultra3000 drives)
- Dual Position Servo
- Dual Command Servo
- Aux Dual Command Servo
- Velocity Servo
- Torque Servo
- Dual Command/Feedback Servo

Drive Resolution

Type in the number of counts per motor revolution, motor inch, or motor millimeter. This value applies to all position data. Valid values range from 1 to 2^32 - 1. One Least Significant Bit (LSB) for position data equals 360° / Rotational Position Resolution.

> **Note:** Drive Resolution is also referred to as Rotational Position Resolution.

When you save an edited Drive Resolution value, a message box appears, asking you if you want the controller to automatically recalculate certain attribute settings.

Drive Resolution is especially helpful for either fractional unwind applications or multi-turn applications requiring cyclic compensation. You can modify the Drive Resolution value so that dividing it by the Unwind Value yields a whole integer value. The higher the Drive Resolution setting, the finer the resolution.

Drive Enable Input Checking

To activate Drive Enable Input Checking click on the checkbox. When active (box is checked) the drive regularly monitors the state of the Drive Enable Input. This dedicated input enables the drive's power structure and servo loop. If Drive Enable Input Checking is not active then no such checking of the Drive Enable Input occurs.

Drive Enable Input Fault

Click on the checkbox to activate the Drive Enable Input Fault. When active, a fault detected on the external drive notifies the motion module via Drive Fault Input.

Real Time Axis Information

Attribute 1/Attribute 2

Select up to two axis attributes whose status are transmitted – along with the actual position data – to the Logix processor. The values of the selected attributes can be accessed via the standard GSV or Get Attribute List service.

> **Note:** The servo status data update time is precisely the coarse update period.

If a GSV is done to one of these servo status attributes without the having selected this attribute via the Drive Info Select attribute, the attribute value is static and does not reflect the true value in the servo module.

Change Catalog…button

The Change Catalog button accesses the motor database and provides for selecting a new motor catalog number. There are three boxes that can be used for refine the selection process.

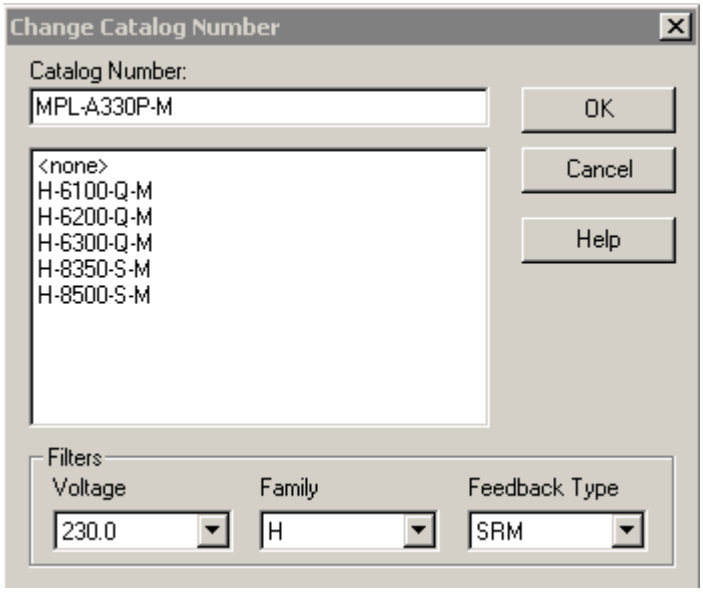


Figure 6.18 Change Catalog Screen

Catalog Number

Lists the available catalog numbers from the Motor Database based on any selection criteria from the Filters fields.

Filters

There are three optional Filter fields that allow you to refine your search of the Motor Database. The Filter boxes are defaulted to all.

Voltage

Lets you select a voltage rating from the pull-down list to broaden or narrow your search. The default is all.

Family

The Family filter box pull down list lets you narrow your motor search by restricting it to a particular family of motors. The default is all.

Feedback Type

The Feedback Type filter box pull-down list lets you manipulate your motor search by acceptable Feedback types. The default is all.

Calculate... button

The Calculate Button takes you to an input screen that is designed to calculate the Drive Resolution and Conversion Constant based upon your input for Position Unit Scaling and Position Range for Linear Positioning mode. If you are in Rotary Positioning Mode then it calculates the Drive Resolution, Conversion Constant, and Position Unwind based upon your inputs for Position Unit Scaling and Position Unit Unwind.

When the Conversion screen has Linear as the value for Position Mode, clicking on the Calculate button displays the following screen.

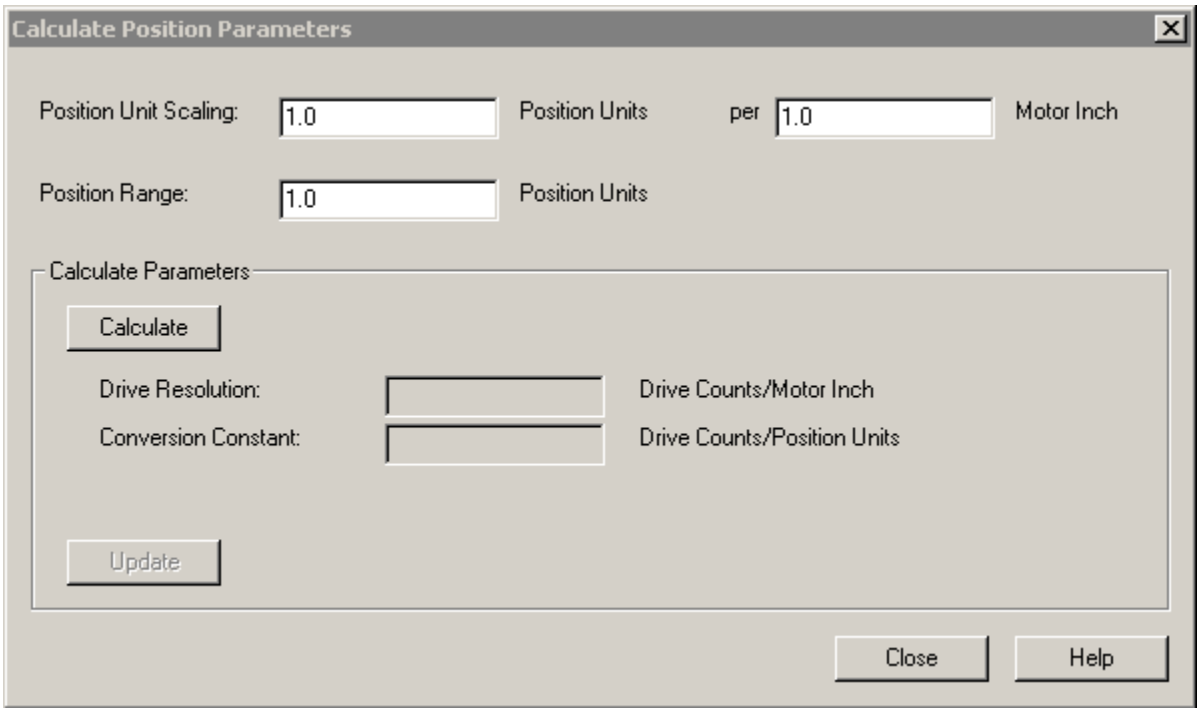


Figure 6.19 Axis Properties – Calculate Screen for Linear

Position Unit Scaling

Position Unit Scaling defines the relationship between the Position Units defined on the Units tab and the units selected to measure position.

Per

The units used for Position Unit Scaling. The options are: Motor Inch, Motor Millimeter, or Motor Rev

Position Range

Maximum travel limit that your system can go.

Position Unit Unwind

For Rotary applications, the Position Unit Unwind field displays. Enter the value for the maximum number of unwinds in position units per unwind cycle.

Calculate Parameters

The Calculate Parameters shows the values that are to be calculated based upon the values entered for the Position Unit Scaling and Position Range.

Drive Resolution

Recalculates the resolution based upon the new values entered on this screen.

Conversion Constant

Recalculates the Conversion Constant based upon the new values entered on this screen.

When the Conversion screen has Rotary as the value for Position Mode, clicking on the Calculate button displays the following screen.

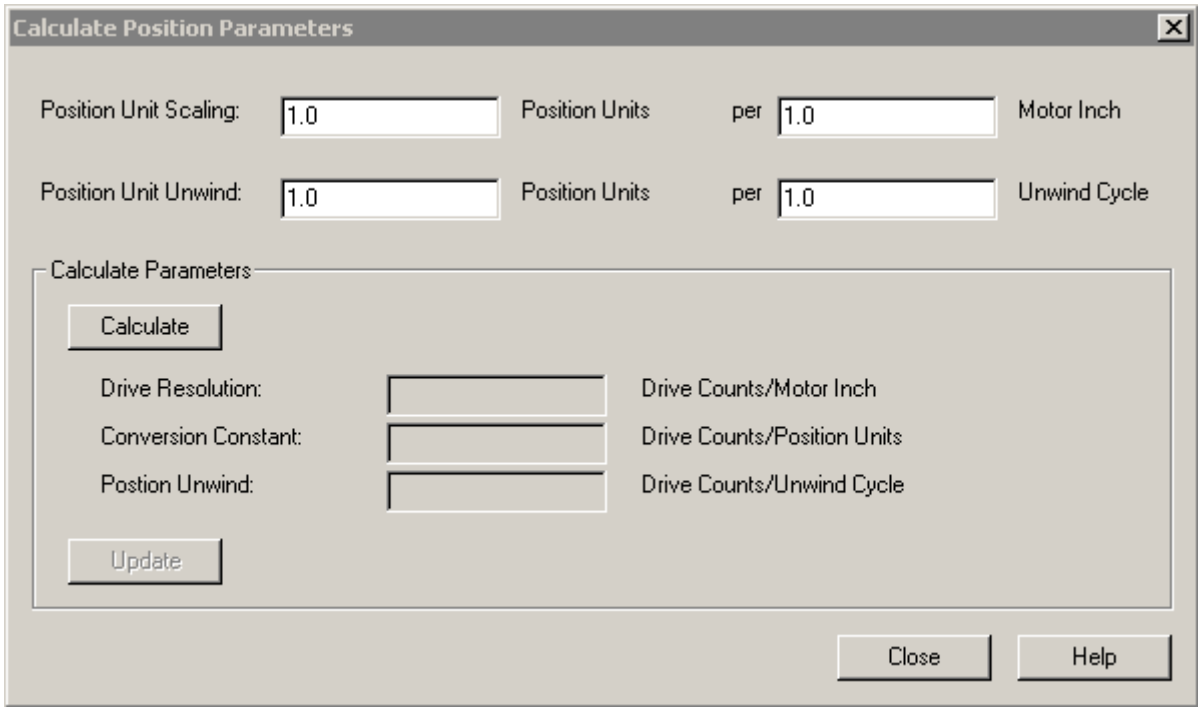


Figure 6.20 Axis Properties – Calculate Screen for Rotary

Motor Feedback Tab - AXIS_SERVO_DRIVE

Use this tab to configure motor and auxiliary feedback device (if any) parameters, for an axis of the type AXIS_SERVO_DRIVE.

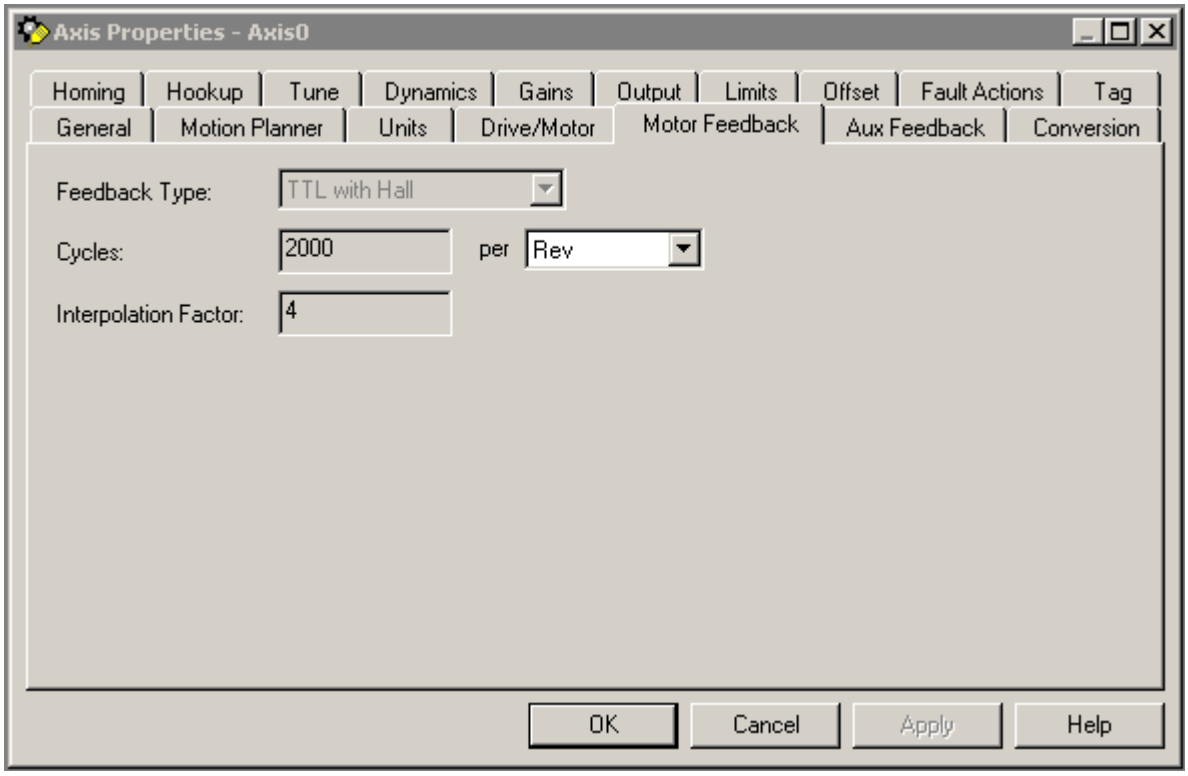


Figure 6.21 Axis Properties - Motor/Feedback Tab for Axis_Servo_Drive

> **Note:** The Axis Configuration selection made on the General tab, and the Loop Configuration selection made on the Drive tab determine which sections of this dialog box – Motor and Auxiliary Feedback – are enabled.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

Feedback Type

This field displays the type of feedback associated with the selected motor.

Cycles

The number of cycles of the associated feedback device. This helps the Drive Compute Conversion constant used to convert drive units to feedback counts. Depending on the feedback type you select, this value may be either read-only or editable.

Per

The units used to measure the cycles.

Interpolation Factor

This field displays a fixed, read-only value for each feedback type. This value is used to compute the resolution of the feedback device.

Aux Feedback Tab - AXIS_SERVO_DRIVE

The Auxiliary Feedback Tab is enabled only if the Drive tab's Loop Configuration field is set to Aux Feedback Only, Aux Position Servo, Dual Position Servo, Dual Command Servo, or Aux Dual Command Servo.

Use this tab to configure motor and auxiliary feedback device (if any) parameters, for an axis of the type AXIS_SERVO_DRIVE.

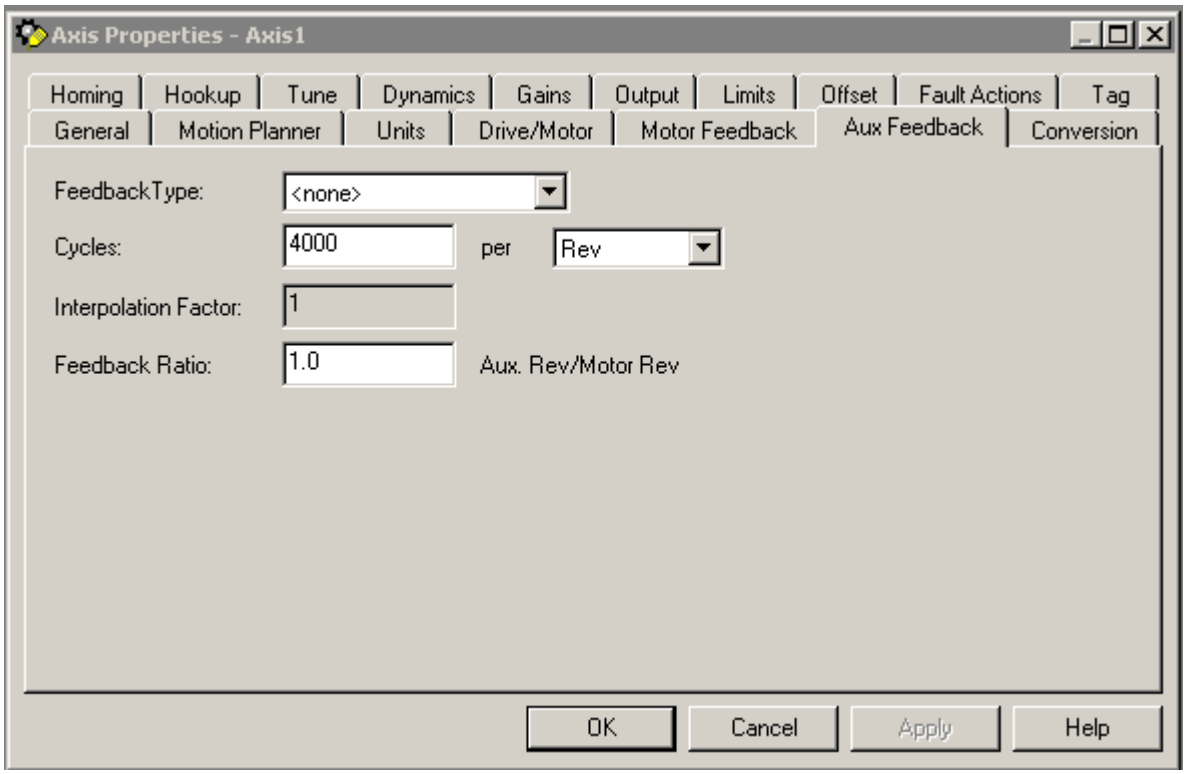


Figure 6.22 Axis Properties - Aux Feedback Tab for Axis_Servo_Drive

Feedback Type

For applications that use auxiliary feedback devices, select the type of auxiliary feedback device type. These are drive dependent.

Cycles

The number of cycles of the auxiliary feedback device. This helps the Drive Compute Conversion constant used to convert drive units to feedback counts. Depending on the feedback type selected, this value may either be read-only or editable.

Per

The units used to measure the cycles.

Interpolation Factor

This field displays a fixed constant value for the selected feedback type. This value is used to compute the resolution of the feedback device.

Feedback Ratio

Represents the quantitative relationship between the auxiliary feedback device and the motor.

Click on the Conversion Tab to access the Axis Properties Conversion dialog.

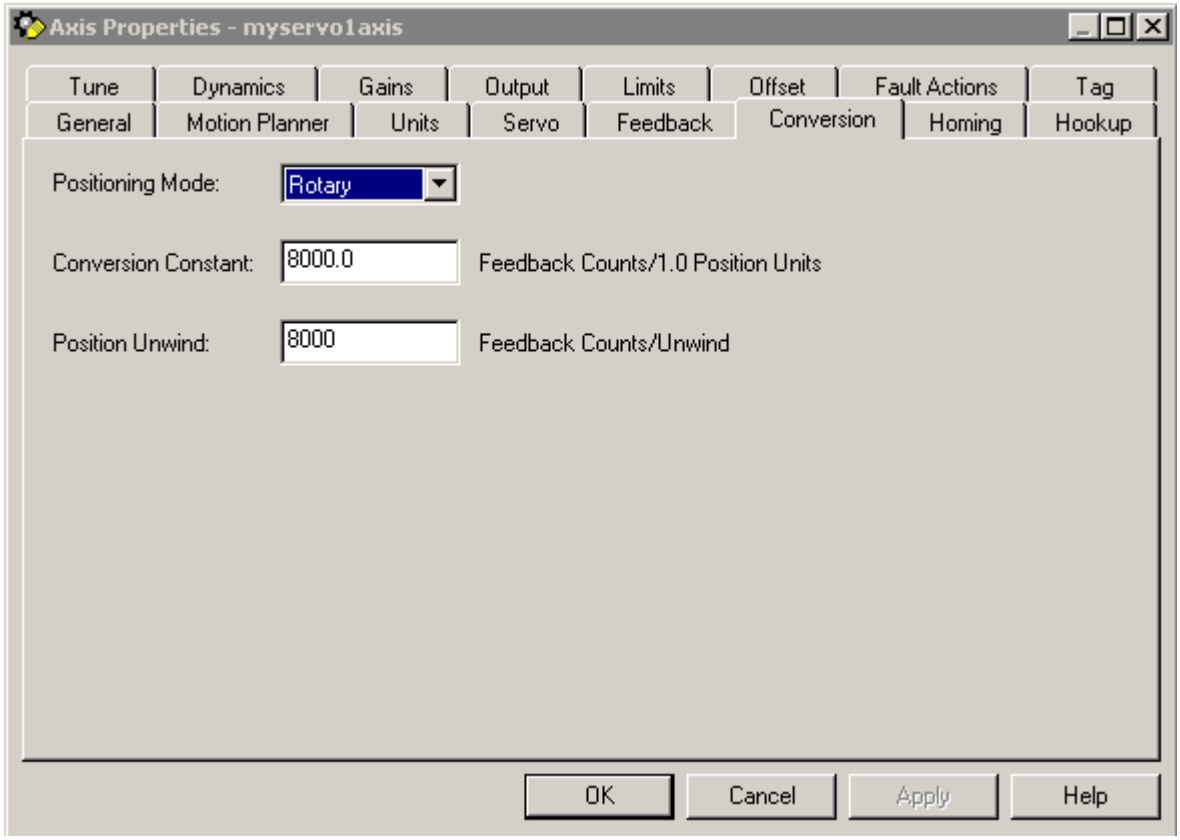


Figure 6.23 Axis Properties - AXIS_SERVO Conversion Tab

The differences in the appearance of the Conversion Tab screens for the AXIS_SERVO and AXIS_SERVO_DRIVE are the default values for Conversion Constant and Position Unwind and the labels for these values.

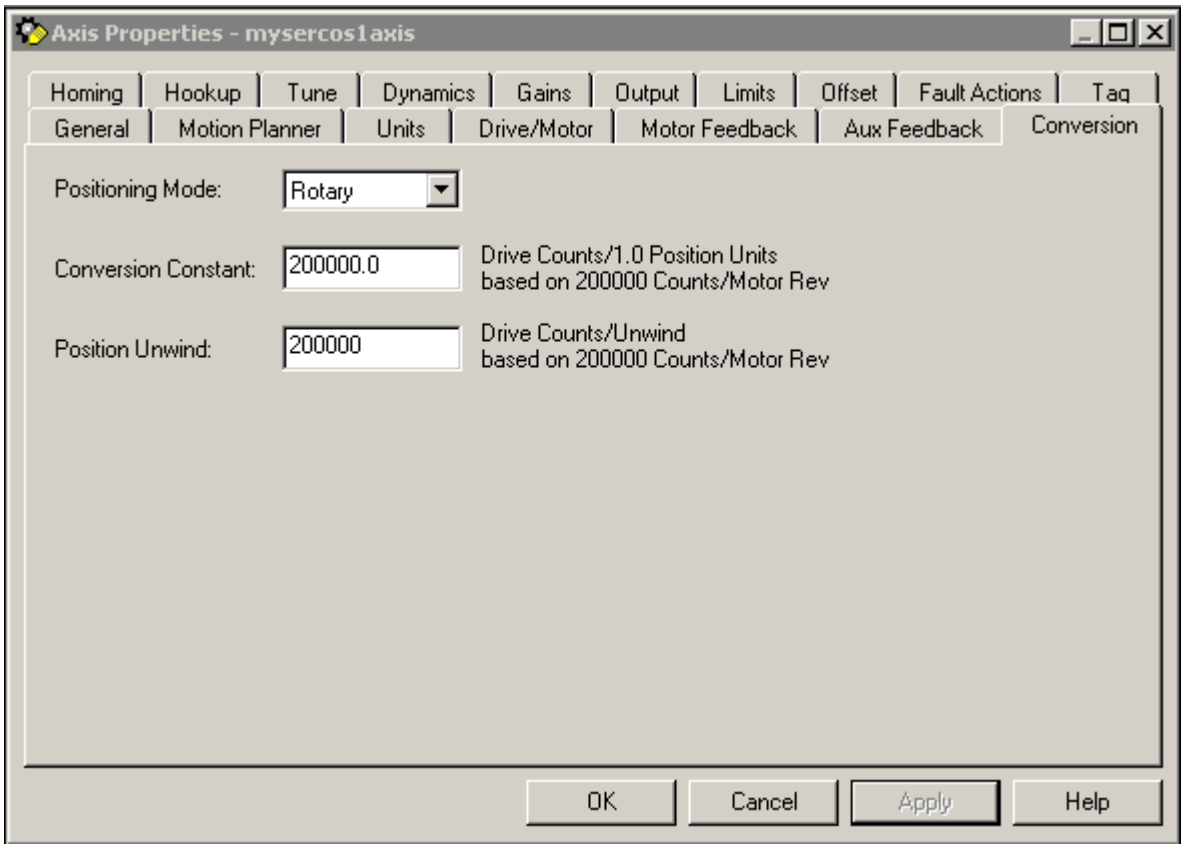


Figure 6.24 Axis Properties - AXIS_SERVO_DRIVE Conversion Tab

Conversion Tab

Use this tab to view/edit the Positioning Mode, Conversion Constant, and if configured as Rotary, the Unwind values for an axis, of the tag types AXIS_SERVO, AXIS_SERVO_DRIVE and AXIS_VIRTUAL.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Positioning Mode

This parameter is not editable for an axis of the data type AXIS_CONSUMED. Instead, this value is set in and taken from a producing axis in a networked Logix processor. This value can be edited for AXIS_SERVO, AXIS_SERVO_DRIVE and AXIS_VIRTUAL. The option are:

- Linear - provides a maximum total linear travel of 1 billion feedback counts. With this mode, the unwind feature is disabled and you can limit the linear travel distance traveled by the axis by specifying the positive and negative travel limits for the axis.

- Rotary - enables the rotary unwind capability of the axis. This feature provides infinite position range by unwinding the axis position whenever the axis moves through a complete unwind distance. The number of encoder counts per unwind of the axis is specified by the Position Unwind parameter.

Conversion Constant

Type the number of feedback counts per position unit. This conversion – or "K" – constant allows axis position to be displayed, and motion to be programmed, in the position units set in the Units tab. The conversion constant is used to convert axis position units into feedback counts and vice versa for the AXIS_SERVO type and for the AXIS_SERVO_DRIVE, the number of counts per motor revolution, as set in the Drive Resolution field of the Drive tab.

Position Unwind

This parameter is not editable for an axis of the data type AXIS_CONSUMED. Instead, this value is set in and taken from a producing axis in a networked Logix processor. For a Rotary axis (AXIS_SERVO), this value represents the distance (in feedback counts) used to perform automatic electronic unwind. Electronic unwind allows infinite position range for rotary axes by subtracting the unwind distance from both the actual and command position, every time the axis travels the unwind distance.

For axes of the type AXIS_SERVO_DRIVE:

- when you save an edited Conversion Constant or a Drive Resolution value, a message box appears, asking you if you want the controller to automatically recalculate certain attribute settings. (Refer to Conversion Constant and Drive Resolution Attributes.)

- the label indicates the number of counts per motor revolution, as set in the Drive Resolution field of the Drive tab.

Click on Apply to accept your changes.

Homing Tab - AXIS_SERVO and AXIS_SERVO_DRIVE

Use this tab to configure the attributes related to homing an axis of the type AXIS_SERVO or AXIS_SERVO_DRIVE.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

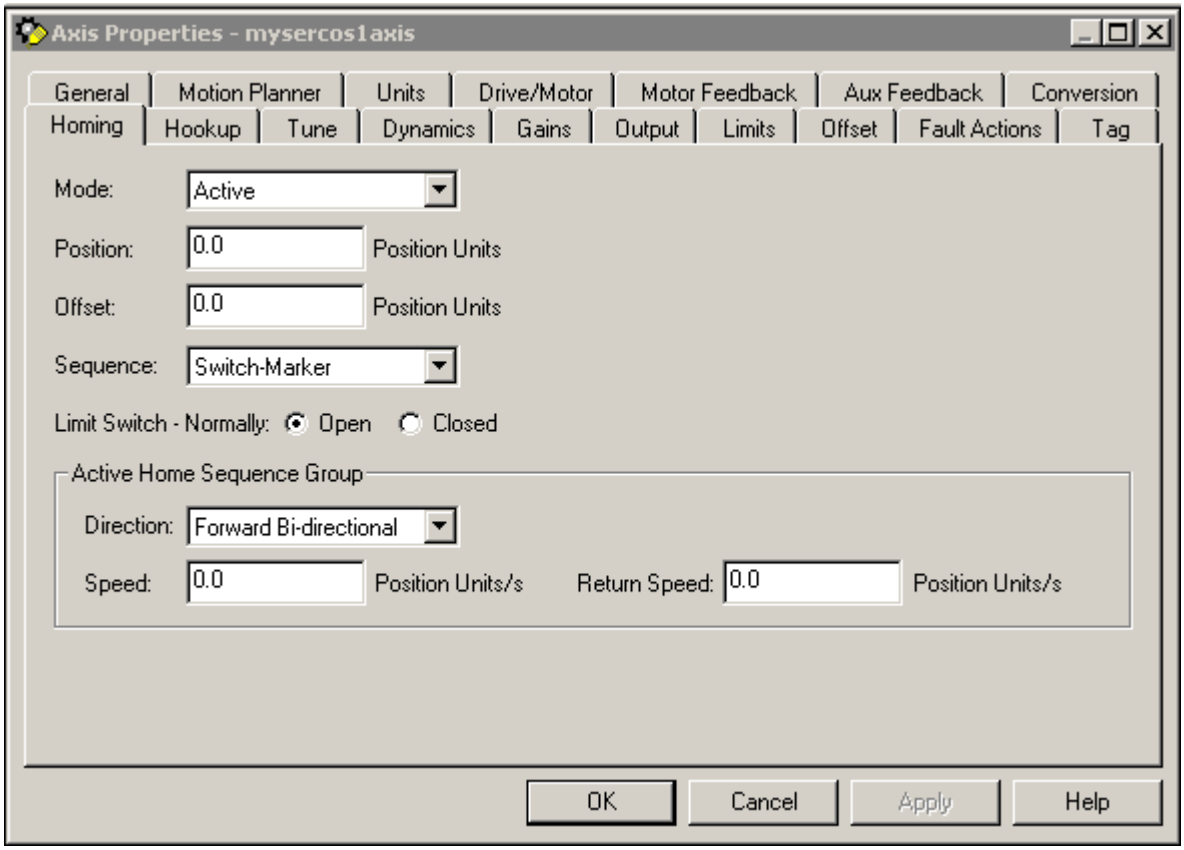


Figure 6.25 Axis Properties - Homing Tab for Axis_Servo_Drive

Mode

Select the homing mode:

- Active: In this mode, the desired homing sequence is selected by specifying whether a home limit switch and/or the encoder marker is used for this axis. Active homing sequences always use the trapezoidal velocity profile. For LDT and SSI feedback selections, the only valid Home Sequences for Homing Mode are immediate or switch, as no physical marker exists for the LDT or SSI feedback devices.

- Passive: In this mode, homing redefines the absolute position of the axis on the occurrence of a home switch or encoder marker event. Passive homing is most commonly used to calibrate uncontrolled axes, although it can also be used with controlled axes to create a custom homing sequence. Passive homing, for a given home sequence, works similar to the corresponding active homing sequence, except that no motion is commanded; the controller just waits for the switch and marker events to occur.

- Absolute: (AXIS_SERVO_DRIVE, and AXIS_SERVO when associated with a 1756-HYD02 [LDT feedback] or 1756-M02AS [SSI feedback] module only) In this mode, the absolute homing process establishes the true absolute position of the axis by applying the configured Home Position to the reported position of the absolute feedback device. The only valid Home Sequence for an absolute Homing Mode is immediate. In the LDT and SSI cases, the absolute homing process establishes the true absolute position of the axis by applying the configured Home Position less any enabled Absolute Feedback Offset to the reported position of the absolute feedback device. Prior to execution of the absolute homing process using the MAH instruction, the axis must be in the Axis Ready state with the servo loop disabled.

IMPORTANT

For the SSI feedback transducer no physical marker pulse exists. However, a pseudo marker reference is established by the M02AS module firmware at the feedback device's roll over point. A single-turn Absolute SSI feedback device rolls over at its maximum "turns count" = 1 rev. A multi-turn Absolute SSI feedback device (there are multiple revs or feedback-baseunit-distances) the device rolls over at its maximum "turns count" which is usually either 1024 or 2048.

If you need to establish the roll-over of the feedback device, a ladder rung using an SSV to set Home_Sequence equal "Home to marker" with the following parameters: Class Name = SSI_Axis, Attribute_Name = Home_Sequence, and Value = 2 (to Marker) must be added to the application program (cannot be set Axis Properties and must be reset back to its initial value 0 = Immediate or 1 = Switch after establishing the roll-over). The Home Sequence = to Marker must be used to allow feedback to travel until the roll-over (i.e. pseudo marker) is found. This must be done without the motor attached to any axis as this could cause up to Maximum number of turn's before pseudo marker is found.

Position

Type the desired absolute position, in position units, for the axis after the specified homing sequence has been completed. In most cases, this position is set to zero, although any value within the software travel limits can be used. After the homing sequence is complete, the axis is left in this position.

If the Positioning Mode (set in the Conversion tab) of the axis is Linear, then the home position should be within the travel limits, if enabled. If the Positioning Mode is Rotary, then the home position should be less than the unwind distance in position units.

Offset

Type the desired offset (if any) in position units the axis is to move, upon completion of the homing sequence, to reach the home position. In most cases, this value is zero.

Sequence

Select the event that causes the Home Position to be set:

Sequence Type:	Description:
Immediate	Sets the Home Position to the present actual position, without motion.
Switch	Sets the Home Position when axis motion encounters a home limit switch.
Marker	Sets the Home Position when axis encounters an encoder marker.
Switch-Marker	Sets the Home Position when axis first encounters a home limit switch, then encounters an encoder marker.

Note: See the section "Homing Configurations," below, for a detailed description of each combination of homing mode, sequence and direction.

Limit Switch

If a limit switch is used, indicate the normal state of that switch (i.e., before being engaged by the axis during the homing sequence):

- Normally Open
- Normally Closed

Direction

For active homing sequences, except for the Immediate Sequence type, select the desired homing direction:

Direction	Description
Forward Uni-directional	The axis jogs in the positive axial direction until a homing event (switch or marker) is encountered, then continues in the same direction until axis motion stops (after decelerating or moving the Offset distance).
Forward Bi-directional	The axis jogs in the positive axial direction until a homing event (switch or marker) is encountered, then reverses direction until motion stops (after decelerating or moving the Offset distance).
Reverse Uni-directional	The axis jogs in the negative axial direction until a homing event (switch or marker) is encountered, then continues in the same direction until axis motion stops (after decelerating or moving the Offset distance).
Reverse Bi-directional	The axis jogs in the negative axial direction until a homing event (switch or marker) is encountered, then reverses direction until motion stops (after decelerating or moving the Offset distance).

Speed

Type the speed of the jog profile used in the first leg of an active homing sequence. The homing speed specified should be less than the maximum speed and greater than zero.

Return Speed

The speed of the jog profile used in the return leg(s) of an active homing sequence. The home return speed specified should be less than the maximum speed and greater than zero.

Homing Configurations

The following examples of Active and Passive homing assume that the initial motion, if any, is in a positive axial direction. Click on an individual homing configuration for more information.

- Active Homing Configurations
- Active Immediate Home
- Active Bi-directional Home with Switch
- Active Bi-directional Home with Marker
- Active Bi-directional Home with Switch then Marker
- Active Uni-directional Home with Switch
- Active Uni-directional Home with Marker

- Active Uni-directional Home with Switch then Marker
- Passive Homing Configurations
- Passive Immediate Home
- Passive Home with Switch
- Passive Home with Marker
- Passive Home with Switch then Marker

Homing Tab - AXIS_VIRTUAL

Use this tab to configure the attributes related to homing an axis of the type AXIS_VIRTUAL.

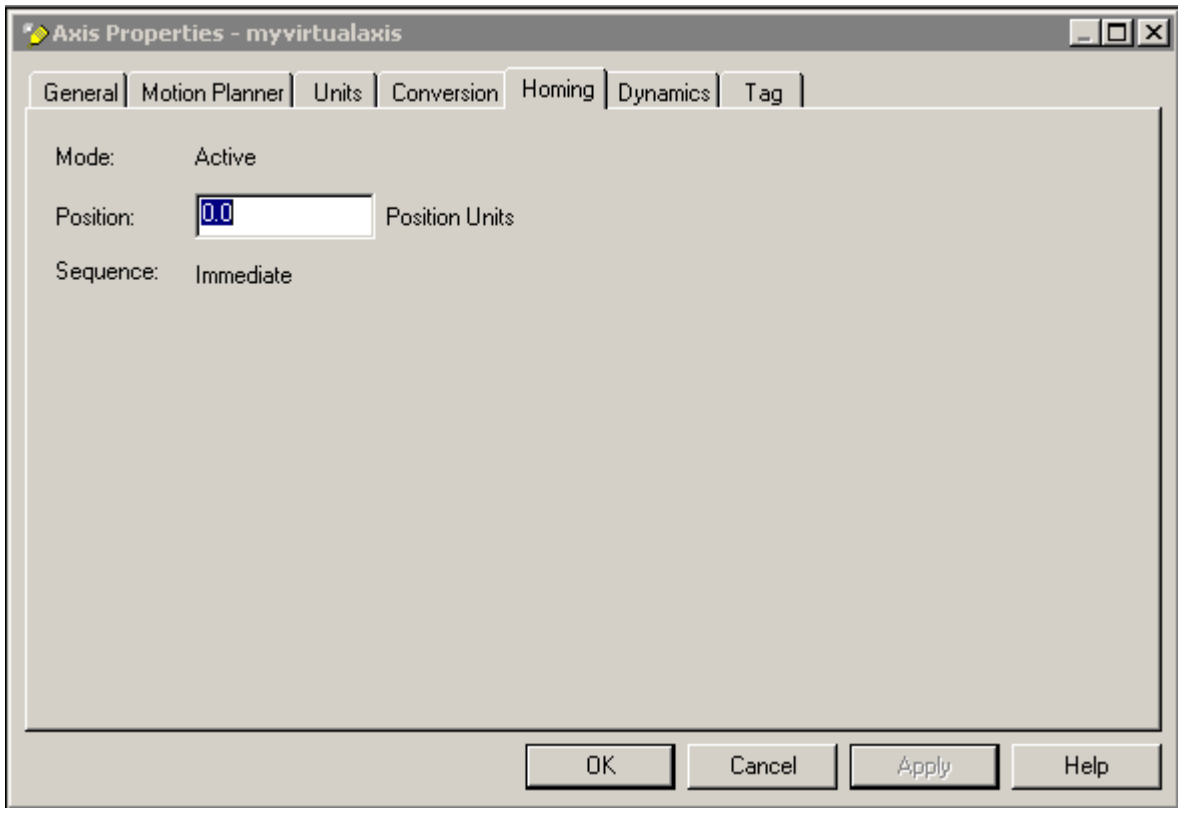


Figure 6.26 Axis Properties - Homing Tab for Virtual Axis Data Type

Only an Active Immediate Homing sequence can be performed for an axis of the type AXIS_VIRTUAL. When this sequence is performed, the controller immediately enables the servo drive and assigns the Home Position to the current axis actual position and command position. This homing sequence produces no axis motion.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

Mode

This read-only parameter is always set to Active.

Position

Type the desired absolute position, in position units, for the axis after the specified homing sequence has been completed. In most cases, this position is set to zero, although any value within the software travel limits can be used. After the homing sequence is complete, the axis is left at this position.

If the Positioning Mode (set in the Conversion tab) of the axis is Linear, then the home position should be within the travel limits, if enabled. If the Positioning Mode is Rotary, then the home position should be less than the unwind distance in position units.

Sequence

This read-only parameter is always set to Immediate.

Hookup Tab - AXIS_SERVO

Use this tab to configure and initiate axis hookup and marker test sequences for an axis of the type AXIS_SERVO.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

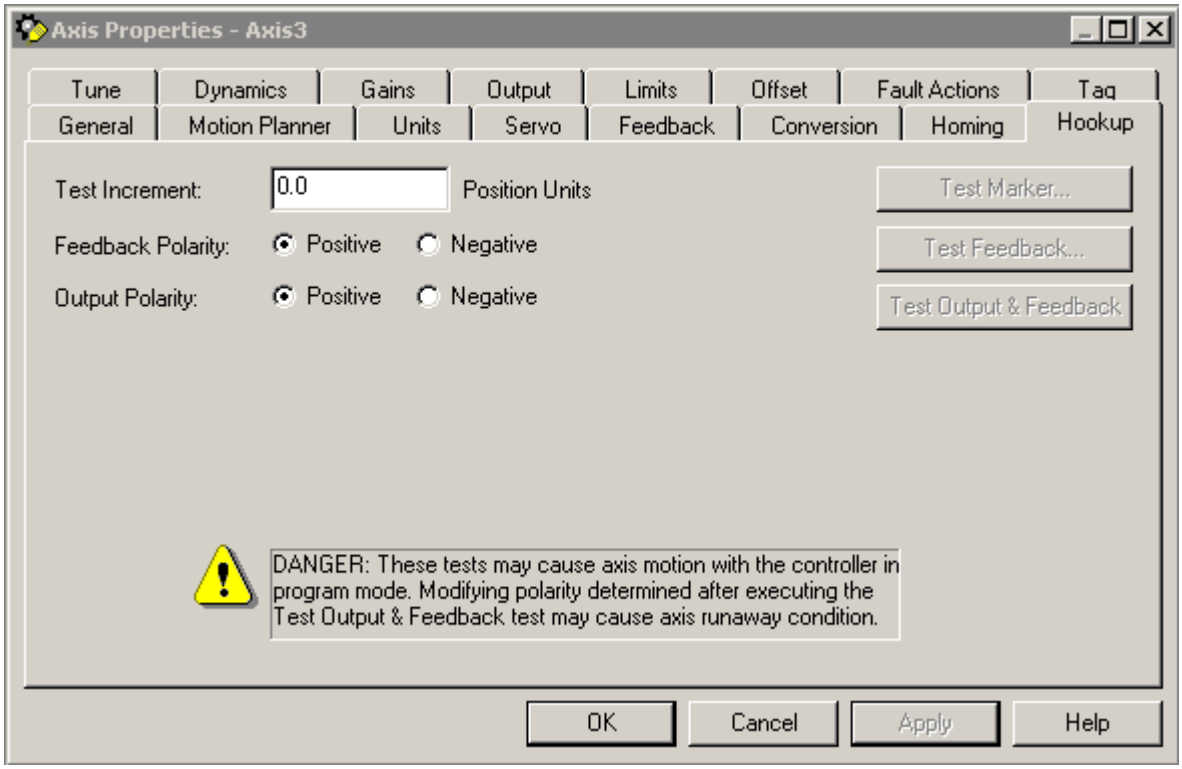


Figure 6.27 Axis Properties - Hookup Tab for Axis_Servo

Test Increment

Specifies the amount of distance traversed by the axis when executing the Output & Feedback test. The default value is set to approximately a quarter of a revolution of the motor in position units.

Feedback Polarity

The polarity of the encoder feedback, this field is automatically set by executing either the Feedback Test or the Output & Feedback Test:

- Positive
- Negative

Note: When properly configured, this setting insures that axis Actual Position value increases when the axis is moved in the user defined positive direction. This bit can be configured automatically using the MRHD and MAHD motion instructions.

ATTENTION

Modifying automatically input polarity values by running the Feedback or Output & Feedback Tests can cause a runaway condition resulting in unexpected motion, damage to the equipment, and physical injury or death.

Output Polarity

The polarity of the servo output to the drive, this field is automatically set by executing the Output & Feedback Test:

- Positive
- Negative

Note: When properly configured, this setting and the Feedback Polarity setting insure that, when the axis servo loop is closed, it is closed as a negative feedback system and not an unstable positive feedback system. This bit can be configured automatically using the MRHD and MAHD motion instructions.

Test Marker

Runs the Marker test, which ensures that the encoder A, B, and Z channels are connected correctly and phased properly for marker detection. When the test is initiated, you must manually move the axis one revolution for the system to detect the marker. If the marker is not detected, check the encoder wiring and try again.

Test Feedback

Runs the Feedback Test, which checks and, if necessary, reconfigures the Feedback Polarity setting. When the test is initiated, you must manually move the axis one revolution for the system to detect the marker. If the marker is not detected, check the encoder wiring and try again.

Test Output & Feedback

Runs the Output & Feedback Test, which checks and, if necessary, reconfigures both the polarity of encoder feedback (the Feedback Polarity setting) and the polarity of the servo output to the drive (the Output Polarity setting), for an axis configured for Servo operation in the General tab.

Note: Executing any test operation automatically saves all changes to axis properties.

Hookup Tab Overview - AXIS_SERVO_DRIVE

Use this tab to configure and initiate axis hookup and marker test sequences for an axis of the type AXIS_SERVO_DRIVE.

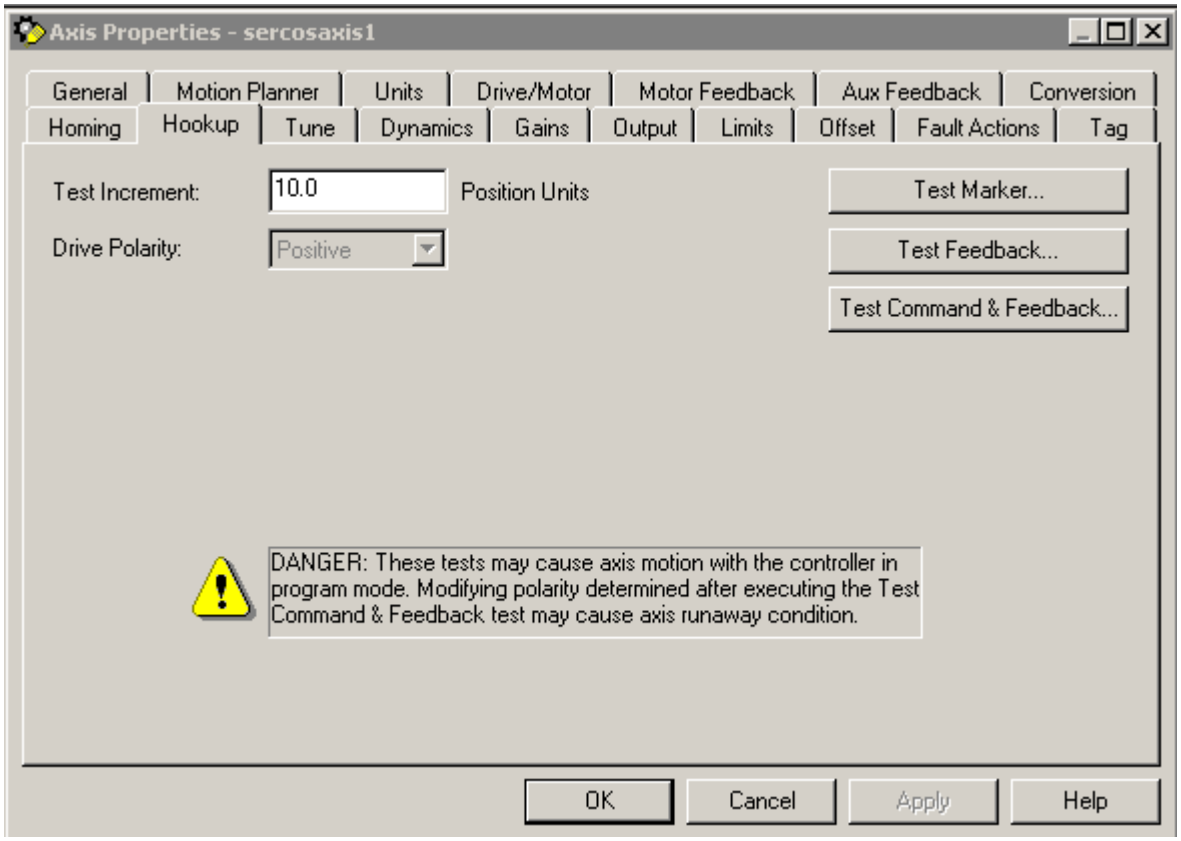


Figure 6.28 Axis Properties - Hookup Tab for Axis_Servo_Drive

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

Test Increment

Specifies the amount of distance traversed by the axis when executing the Command & Feedback test. The default value is set to approximately a quarter of a revolution of the motor in position units.

Drive Polarity

The polarity of the servo loop of the drive, set by executing the Command & Feedback Test:

- Positive
- Negative

Note: Proper wiring guarantees that the servo loop is closed with negative feedback. However there is no guarantee that the

servo drive has the same sense of forward direction as the user for a given application. Negative Polarity inverts the polarity of both the command position and actual position data of the servo drive. Thus, selecting either Positive or Negative Drive Polarity makes it possible to configure the positive direction sense of the drive to agree with that of the user. This attribute can be configured automatically using the MRHD and MAHD motion instructions.

ATTENTION

Modifying polarity values, automatically input by running the Command & Feedback Test, can cause a runaway condition.

Test Marker

Runs the Marker test, which ensures that the encoder A, B, and Z channels are connected correctly and phased properly for marker detection. When the test is initiated, you must manually move the axis one revolution for the system to detect the marker. If the marker is not detected, check the encoder wiring and try again.

Test Feedback

Runs the Feedback Test, which checks and, if necessary, reconfigures the Feedback Polarity setting. When the test is initiated, you must manually move the axis one revolution for the system to detect the marker. If the marker is not detected, check the encoder wiring and try again.

Test Command & Feedback

Runs the Command & Feedback Test, which checks and, if necessary, reconfigures both the polarity of encoder feedback (the Feedback Polarity setting) and the polarity of the servo output to the drive (the Output Polarity setting), for an axis configured for Servo operation in the General tab.

Note: Executing any test operation automatically saves all changes to axis properties.

Tune Tab - AXIS_SERVO, AXIS_SERVO_DRIVE

Use this tab to configure and initiate the axis tuning sequence for an axis of the types AXIS_SERVO or AXIS_SERVO_DRIVE.

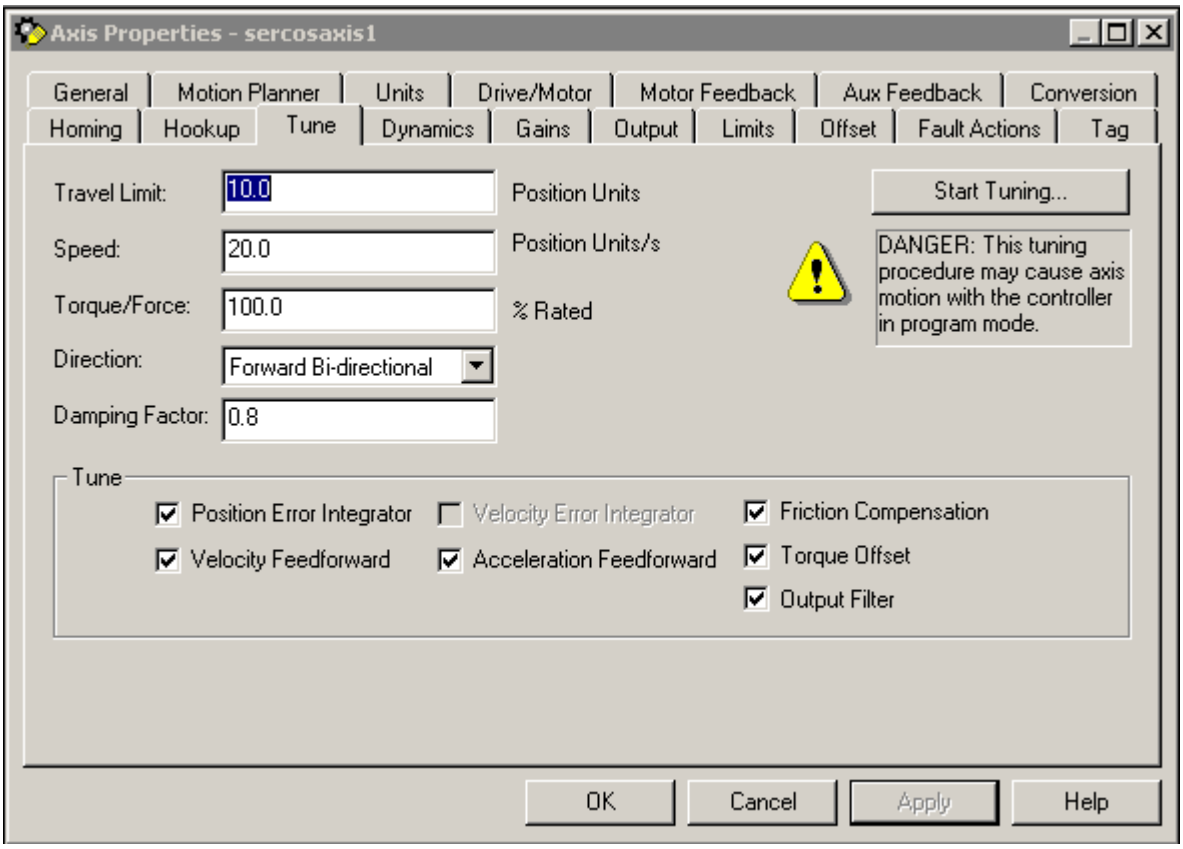


Figure 6.29 Axis Properties - Tune Tab for Axis_Servo_Drive

Travel Limit

Specifies a limit to the excursion of the axis during the tune test. If the servo module determines that the axis is not able to complete the tuning process before exceeding the tuning travel limit, it terminates the tuning profile and report that this limit was exceeded.

Speed

Determines the maximum speed for the tune process. This value should be set to the desired maximum operating speed of the motor (in engineering units) prior to running the tune test.

Torque/Force (AXIS_SERVO_DRIVE)

The maximum torque of the tune test. Force is used only when a linear motor is connected to the application. This attribute should be set to the desired maximum safe torque level prior to running the tune test. The default value is 100%, which yields the most accurate

measure of the acceleration and deceleration capabilities of the system.

> **Note:** In some cases a lower tuning torque limit value may be desirable to limit the stress on the mechanics during the tuning procedure. In this case the acceleration and deceleration capabilities of the system are extrapolated based on the ratio of the tuning torque to the maximum torque output of the system. Extrapolation error increases as the Tuning Torque value decreases.

Torque (AXIS_SERVO)

The maximum torque of the tune test. This attribute should be set to the desired maximum safe torque level prior to running the tune test. The default value is 100%, which yields the most accurate measure of the acceleration and deceleration capabilities of the system.

> **Note:** In some cases a lower tuning torque limit value may be desirable to limit the stress on the mechanics during the tuning procedure. In this case the acceleration and deceleration capabilities of the system are extrapolated based on the ratio of the tuning torque to the maximum torque output of the system. Extrapolation error increases as the Tuning Torque value decreases.

Direction

The direction of the tuning motion profile. The following options are available:

- Forward Uni-directional – the tuning motion profile is initiated in the forward tuning direction only.
- Forward Bi-directional – the tuning motion profile is first initiated in the forward tuning direction and then, if successful, is repeated in the reverse direction. Information returned by the Bi-directional Tuning profile can be used to tune Friction Compensation and Torque Offset.
- Reverse Uni-directional – the tuning motion profile is initiated in the reverse tuning direction only.
- Reverse Bi-directional – the tuning motion profile is first initiated in the reverse tuning direction and then, if successful, is repeated in the forward direction. Information returned by the Bi-directional Tuning profile can be used to tune Friction Compensation and Torque Offset.

Damping Factor

Specifies the dynamic response of the servo axis. The default is set to 0.8. When gains are tuned using a small damping factor, a step response test performed on the axis may generate uncontrolled oscillation. The gains generated using a larger damping factor would produce a system step response that has no overshoot and is stable, but may be sluggish in response to changes.

> **Note:** The tuning procedure uses the Damping Factor that is set in this field. However, when the controller recalculates certain attributes in response to a Motor Catalog Number change (on the Motor/Feedback tab), the controller uses the default Damping Factor value of 0.8, and not a different value set in this field.

Tune

Select the gains to be determined by the tuning test:

- Position Error Integrator – determines whether or not to calculate a value for the Position Integral Gain.
- Velocity Feedforward – determines whether or not to calculate a value for the Velocity Feedforward Gain.
- Velocity Error Integrator – determines whether or not to calculate a value for the Velocity Integral Gain.
- Acceleration Feedforward – determines whether or not to calculate a value for the Acceleration Feedforward Gain.
- Friction Compensation – determines whether or not to calculate a value for the Friction Compensation Gain.
- Torque Offset – determines whether or not to calculate a value for the Torque Offset. This tuning configuration is only valid if configured for bi-directional tuning.
- Output Filter – determines whether or not to calculate a value for the Output Filter Bandwidth.

Start Tuning

Click on this button to begin the tuning test. If the tuning process completes successfully the following attributes are set.

On this tab:	These attributes are set:
Gains tab	Velocity Feedforward Gain (if checked under Tune, above) Acceleration Feedforward Gain (if checked under Tune, above) Position Proportional Gain Position Integral Gain (if checked under Tune, above) Velocity Proportional Gain Velocity Integral Gain (if checked under Tune, above)
Dynamics tab	Maximum Velocity Maximum Acceleration Maximum Deceleration
Output tab	Torque Scaling Velocity Scaling (AXIS_SERVO only) Low Pass Output Filter (see Note, below)
Limits	Position Error Tolerance

The Tune Bandwidth dialog opens for Servo drives, where you can "tweak" bandwidth values.

> **Note:** During tuning, if the controller detects a high degree of tuning inertia, it enables the Low Pass Output Filter and calculates and sets a value for Low Pass Output Filter Bandwidth.

Executing a Tune operation automatically saves all changes to axis properties.

ATTENTION

This tuning procedure may cause axis motion with the controller in program mode. Unexpected motion may cause damage to the equipment, personal injury, or death.

Dynamics Tab

Use this tab to view or edit the dynamics related parameters for an axis of the type AXIS_SERVO or AXIS_SERVO_DRIVE configured for

Servo operations in the General tab of this dialog box, or AXIS_VIRTUAL.

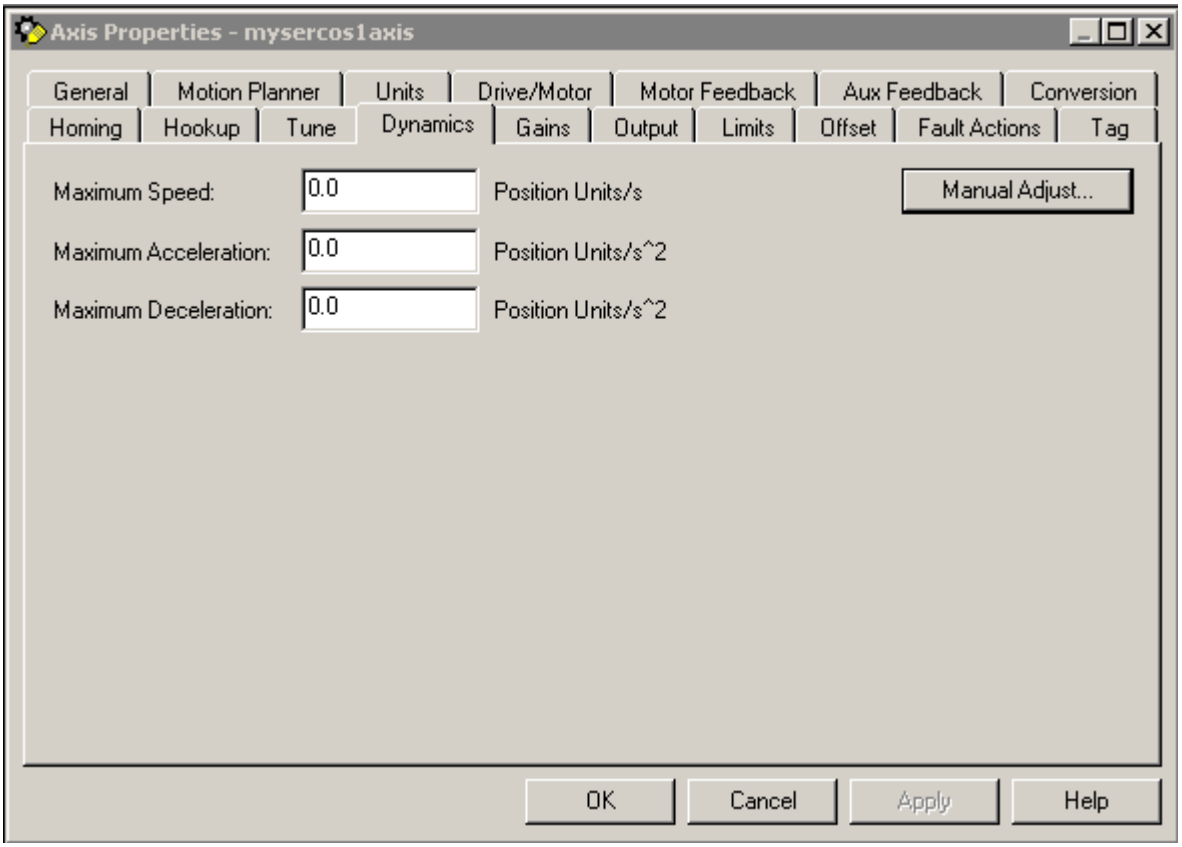


Figure 6.30 Axis Properties - Dynamics Tab for Axis_Servo_Drive

IMPORTANT The parameters on this tab can be edited in either of two ways:

- edit on this tab by typing your parameter changes and then clicking on OK or Apply to save your edits
- edit in the Manual Adjust dialog: click on the Manual Adjust button to open the Manual Adjust dialog to this tab and use the spin controls to edit parameter settings. Your changes are saved the moment a spin control changes any parameter value.

  Note: The parameters on this tab become read-only and cannot be edited when the controller is online if the controller is set to Hard Run mode, or if a Feedback On condition exists.

When RSLogix 5000 is offline, the following parameters can be edited and the program saved to disk using either the Save command or by

clicking on the Apply button. You must re-download the edited program to the controller before it can be run.

Maximum Velocity

The steady-state speed of the axis, it is initially set to Tuning Speed by the tuning process. This value is typically set to about 90% of the maximum speed rating of the motor. This provides sufficient "head-room" for the axis to operate at all times within the speed limitations of the motor. Any change in value, caused by manually changing the spin control, is instantaneously sent to the controller.

Maximum Acceleration

The maximum acceleration rate of the axis, in Position Units/second, it is initially set to about 85% of the measured tuning acceleration rate by the tuning process. If set manually, this value should typically be set to about 85% of the maximum acceleration rate of the axis. This provides sufficient "

head-room" for the axis to operate at all times within the acceleration limits of the drive and motor. Any change in value, caused by manually changing the spin control, is instantaneously sent to the controller.

Maximum Deceleration

The maximum deceleration rate of the axis, in Position Units/second, it is initially set to about 85% of the measured tuning deceleration rate by the tuning process. If set manually, this value should typically be set to about 85% of the maximum deceleration rate of the axis. This provides sufficient "head-room" for the axis to operate at all times within the deceleration limits of the drive and motor. Any change in value, caused by manually changing the spin control, is instantaneously sent to the controller.

Manual Adjust

Click on this button to open the Dynamics tab of the Manual Adjust dialog for online editing of the Maximum Velocity, Maximum Acceleration, and Maximum Deceleration parameters.

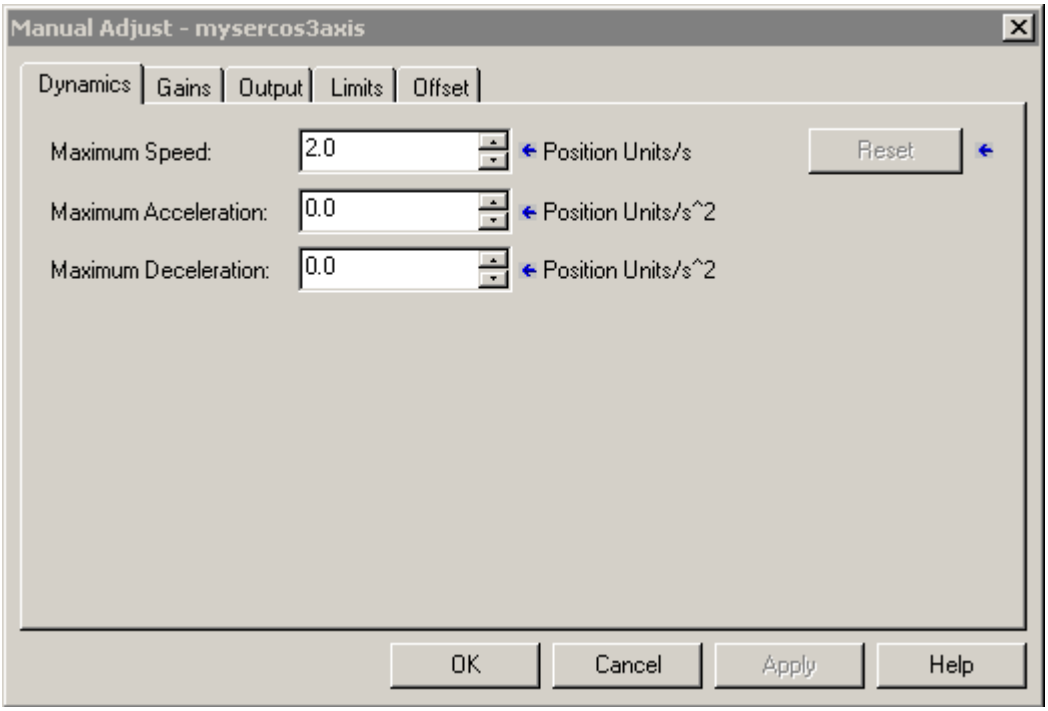


Figure 6.31 Axis Properties - Dynamics Tab Manual Adjust Screen for Axis_Servo_Drive

Note: The Manual Adjust button is disabled when RSLogix 5000 is in Wizard mode, and when offline edits to the above parameters have not yet been saved or applied.

Gains Tab - AXIS_SERVO

Use this tab to perform the following offline functions:

- adjust, or “tweak” gain values that have been automatically set by the tuning process (in the Tune tab of this dialog)
- manually configure gains for the velocity and position loops

for an axis of the type AXIS_SERVO, which has been configured for Servo operations (set in the General tab of this dialog box), with Position Loop Configuration.

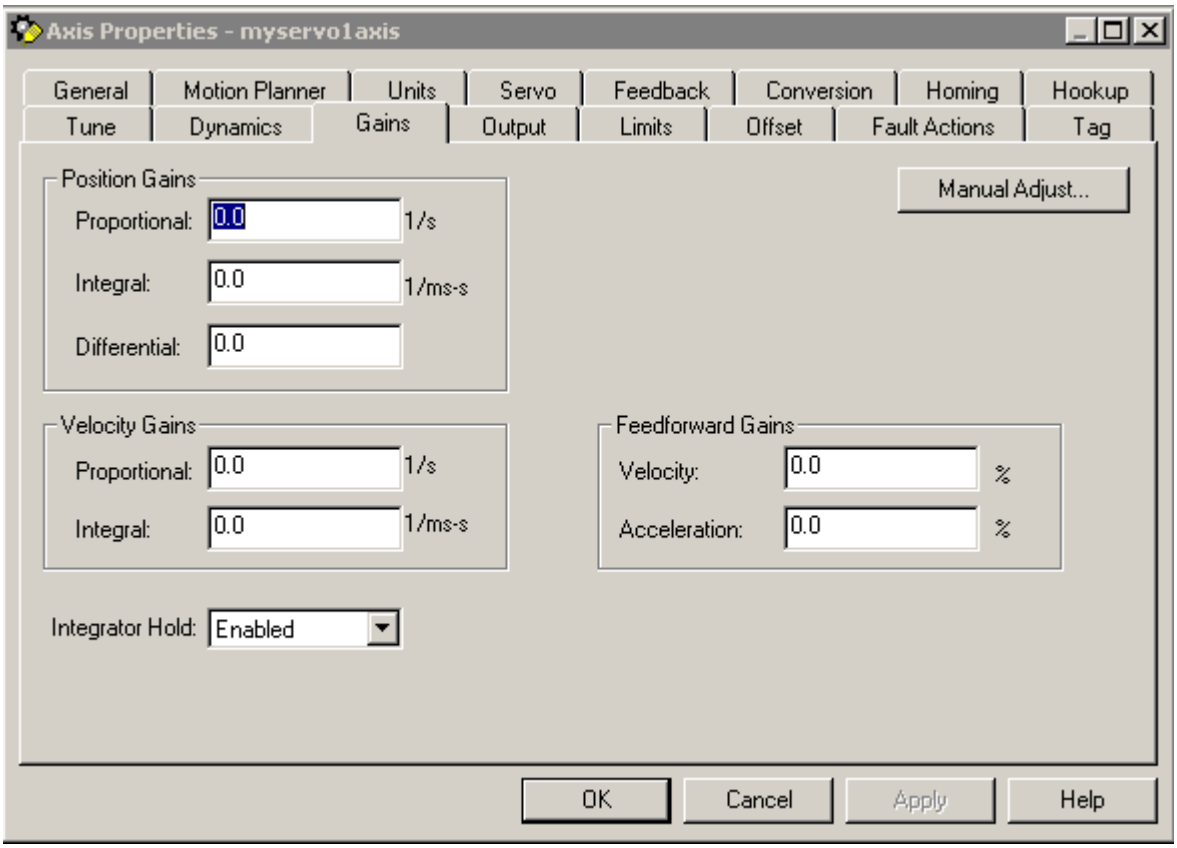


Figure 6.32 Axis Properties - Gains Tab for Axis_Servo

The drive module uses a nested digital servo control loop consisting of a position loop with proportional, integral and feed-forward gains around an optional digitally synthesized inner velocity loop. The parameters on this tab can be edited in either of two ways:

- edit on this tab by typing your parameter changes and then clicking on OK or Apply to save your edits
- edit in the Manual Adjust dialog: click on the Manual Adjust button to open the Manual Adjust dialog to this tab and use the spin controls to edit parameter settings. Your changes are saved the moment a spin control changes any parameter value.

  Note: The parameters on this tab become read-only and cannot be edited when the controller is online if the controller is set to Hard Run mode, or if a Feedback On condition exists.

When RSLogix 5000 is offline, the following parameters can be edited and the program saved to disk using either the Save command or by

clicking on the Apply button. You must re-download the edited program to the controller before it can be run.

Proportional (Position) Gain

Position Error is multiplied by the Position Loop Proportional Gain, or Pos P Gain, to produce a component to the Velocity Command that ultimately attempts to correct for the position error. Too little Pos P Gain results in excessively compliant, or mushy, axis behavior. Too large a Pos P Gain, on the other hand, can result in axis oscillation due to classical servo instability.

To set the gain manually, you must first set the appropriate output scaling factor (either the Velocity Scaling factor or Torque Scaling factor) in the Output tab of this dialog. Your selection of External Drive Configuration type – either Torque or Velocity – in the Servo tab of this dialog determines which scaling factor you must configure before manually setting gains.

If you know the desired loop gain in inches per minute per mil or millimeters per minute per mil, use the following formula to calculate the corresponding P gain:

Pos P Gain = 16.667 * Desired Loop Gain (IPM/mil)

If you know the desired unity gain bandwidth of the position servo in Hertz, use the following formula to calculate the corresponding P gain:

Pos P Gain = Bandwidth (Hertz) * 6.28

The typical value for the Position Proportional Gain is ~100 Sec-1.

Integral (Position) Gain

The Integral (i.e., summation) of Position Error is multiplied by the Position Loop Integral Gain, or Pos I Gain, to produce a component to the Velocity Command that ultimately attempts to correct for the position error. Pos I Gain improves the steady-state positioning performance of the system. Increasing the integral gain generally increases the ultimate positioning accuracy of the system. Excessive integral gain, however, results in system instability.

In certain cases, Pos I Gain control is disabled. One such case is when the servo output to the axis' drive is saturated. Continuing integral control behavior in this case would only exacerbate the situation. When the Integrator Hold parameter is set to Enabled, the servo loop automatically disables the integrator during commanded motion.

While the Pos I Gain, if employed, is typically established by the automatic servo tuning procedure (in the Tuning tab of this dialog), the Pos I Gain value may also be set manually. Before doing this it must be stressed that the Output Scaling factor for the axis must be established for the drive system. Once this is done, the Pos I Gain can be computed based on the current or computed value for the Pos P Gain using the following formula:

Pos I Gain = .025 * 0.001 Sec/mSec * (Pos P Gain)2

Assuming a Pos P Gain value of 100 Sec-1 this results in a Pos I Gain value of 2.5 ~0.1 mSec-1 - Sec-1.

Differential

Position Differential Gain helps predict a large overshoot before it happens and makes the appropriate attempt to correct it before the overshoot actually occurs.

Proportional (Velocity) Gain

Note: This parameter is enabled for all loop types except Torque loop.

Velocity Error is multiplied by the Velocity Proportional Gain to produce a component to the Servo Output or Torque Command that ultimately attempts to correct for the velocity error, creating a damping effect. Thus, increasing the Velocity Proportional Gain results in smoother motion, enhanced acceleration, reduced overshoot, and greater system stability. However, too much Velocity Proportional Gain leads to high frequency instability and resonance effects.

If you know the desired unity gain bandwidth of the velocity servo in Hertz, you can use the following formula to calculate the corresponding P gain.

Velocity P Gain = Bandwidth (Hertz) / 6.28

The typical value for the Velocity Proportional Gain is 250.

Integral (Velocity) Gain

Note: This parameter is enabled for all loop types except Torque loop.

At every servo update the current Velocity Error is accumulated in a variable called the Velocity Integral Error. This value is multiplied by the Velocity Integral Gain to produce a component to the Servo Output or Torque Command that attempts to correct for the velocity

error. The higher the Vel I Gain value, the faster the axis is driven to the zero Velocity Error condition. Unfortunately, I Gain control is intrinsically unstable. Too much I Gain results in axis oscillation and servo instability.

In certain cases, Vel I Gain control is disabled. One such case is when the servo output to the axis' drive is saturated. Continuing integral control behavior in this case would only exacerbate the situation. When the Integrator Hold parameter is set to Enabled, the servo loop automatically disables the integrator during commanded motion.

Due to the destabilizing nature of Integral Gain, it is recommended that Position Integral Gain and Velocity Integral Gain be considered mutually exclusive. If Integral Gain is needed for the application, use one or the other, but not both. In general, where static positioning accuracy is required, Position Integral Gain is the better choice.

The typical value for the Velocity Proportional Gain is ~15 mSec-2.

Velocity Feedforward

Velocity Feedforward Gain scales the current Command Velocity by the Velocity Feedforward Gain and adds it as an offset to the Velocity Command. Hence, the Velocity Feedforward Gain allows the following error of the servo system to be reduced to nearly zero when running at a constant speed. This is important in applications such as electronic gearing, position camming, and synchronization applications, where it is necessary that the actual axis position not significantly lag behind the commanded position at any time. The optimal value for Velocity Feedforward Gain is 100%, theoretically. In reality, however, the value may need to be tweaked to accommodate velocity loops with non-infinite loop gain and other application considerations.

Acceleration Feedforward

Acceleration Feedforward Gain scales the current Command Acceleration by the Acceleration Feedforward Gain and adds it as an offset to the Servo Output generated by the servo loop. With this done, the servo loops do not need to generate much of a contribution to the Servo Output, hence the Position and/or Velocity Error values are significantly reduced. Hence, when used in conjunction with the Velocity Feedforward Gain, the Acceleration Feedforward Gain allows the following error of the servo system during the acceleration and deceleration phases of motion to be reduced to nearly zero. This is important in applications such as electronic gearing, position camming, and synchronization applications, where it is necessary that the actual axis position not significantly lag behind the commanded position at any time. The optimal value for Acceleration Feedforward

is 100%, theoretically. In reality, however, the value may need to be tweaked to accommodate velocity loops with non-infinite loop gain and other application considerations.

Note: Acceleration Feedforward Gain is not applicable for applications employing velocity loop servo drives. Such systems would require the acceleration feedforward functionality to be located in the drive itself.

Integrator Hold

If the Integrator Hold parameter is set to:

- Enabled, the servo loop temporarily disables any enabled position or velocity integrators while the command position is changing. This feature is used by point-to-point moves to minimize the integrator wind-up during motion.
- Disabled, all active position or velocity integrators are always enabled.

Manual Adjust

Click on this button to access the Gains tab of the Manual Adjust dialog for online editing.

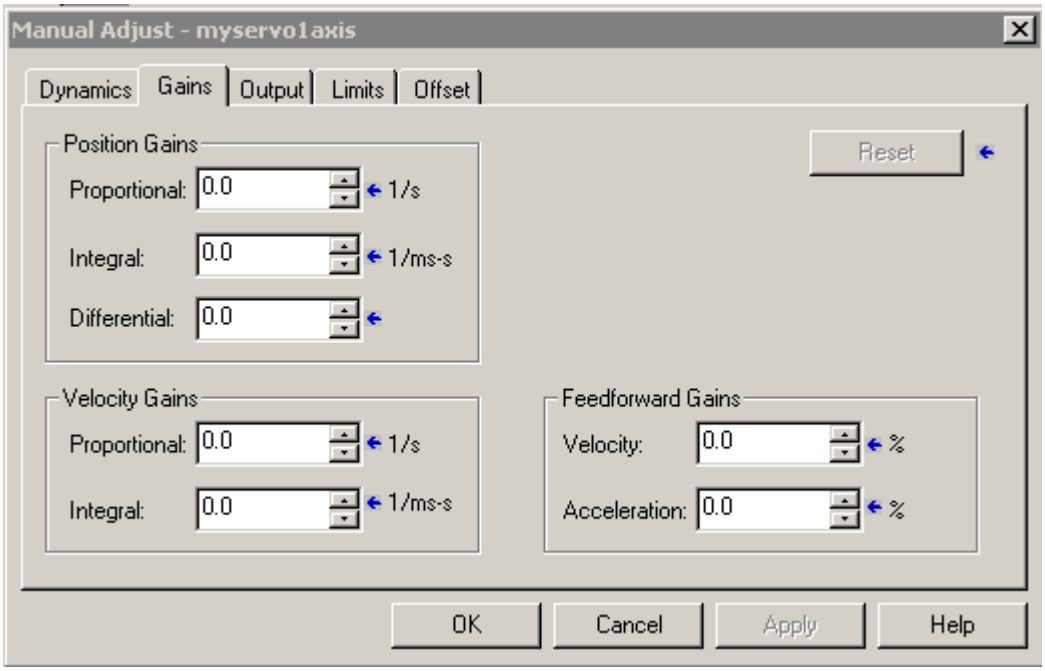


Figure 6.33 Axis Properties - Gains Tab Manual Adjust Screen for Axis_Servo

Note: The Manual Adjust button is disabled when RSLogix 5000 is in Wizard mode, and when you have not yet saved or applied your offline edits to the above parameters.

Gains Tab - AXIS_SERVO_DRIVE Use this tab to perform the following offline functions:

- Adjust, or "tweak" gain values that have been automatically set by the tuning process (in the Tune tab of this dialog)
- Manually configure gains for the velocity and position loops
- for an axis of the type AXIS_SERVO_DRIVE.

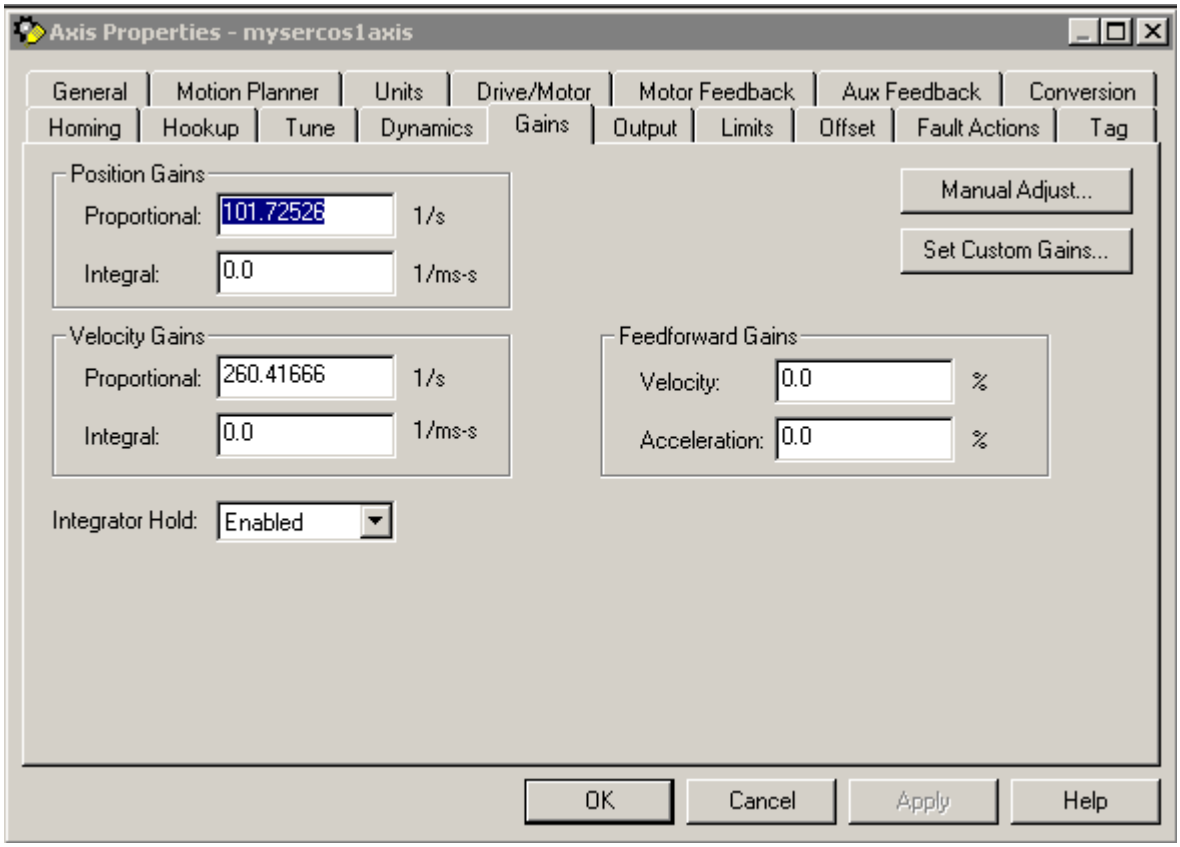


Figure 6.34 Axis Properties - Gains Tab for Axis_Servo_Drive

The drive module uses a nested digital servo control loop consisting of a position loop with proportional, integral and feed-forward gains around an optional digitally synthesized inner velocity loop. The specific design of this nested loop depends upon the Loop Configuration selected in the Drive tab. For a discussion, including a diagram, of a loop configuration, click on the following loop configuration types:

- Motor Position Servo Loop
- Auxiliary Position Servo Loop
- Dual Position Servo Loop
- Motor Dual Command Servo Loop
- Auxiliary Dual Command Servo Loop

- Velocity Servo Loop
- Torque Servo Loop

The parameters on this tab can be edited in either of two ways:

- edit on this tab by typing your parameter changes and then clicking on OK or Apply to save your edits

- edit in the Manual Adjust dialog: click on the Manual Adjust button to open the Manual Adjust dialog to this tab and use the spin controls to edit parameter settings. Your changes are saved the moment a spin control changes any parameter value.

  Note: The parameters on this tab become read-only and cannot be edited when the controller is online if the controller is set to Hard Run mode, or if a Feedback On condition exists.

When RSLogix 5000 is offline, the following parameters can be edited and the program saved to disk using either the Save command or by clicking on the Apply button. You must re-download the edited program to the controller before it can be run.

Velocity Feedforward

Velocity Feedforward Gain scales the current command velocity (derivative of command position) by the Velocity Feedforward Gain and adds it as an offset to the Velocity Command. Hence, the Velocity Feedforward Gain allows the following error of the servo system to be reduced to nearly zero when running at a constant speed. This is important in applications such as electronic gearing and synchronization applications, where it is necessary that the actual axis position not significantly lag behind the commanded position at any time. The optimal value for Velocity Feedforward Gain is 100%, theoretically. In reality, however, the value may need to be tweaked to accommodate velocity loops with non-infinite loop gain and other application considerations.

Acceleration Feedforward

Acceleration Feedforward Gain scales the current Command Acceleration by the Acceleration Feedforward Gain and adds it as an offset to the Servo Output generated by the servo loop. With this done, the servo loops do not need to generate much of a contribution to the Servo Output, hence the Position and/or Velocity Error values are significantly reduced. Hence, when used in conjunction with the Velocity Feedforward Gain, the Acceleration Feedforward Gain allows the following error of the servo system during the acceleration and deceleration phases of motion to be reduced to nearly zero. This is important in applications such as electronic gearing and

synchronization applications, where it is necessary that the actual axis position not significantly lag behind the commanded position at any time. The optimal value for Acceleration Feedforward is 100%, theoretically. In reality, however, the value may need to be tweaked to accommodate velocity loops with non-infinite loop gain and other application considerations.

> **Note:** Acceleration Feedforward Gain is not applicable for applications employing velocity loop servo drives. Such systems would require the acceleration feedforward functionality to be located in the drive itself.

Proportional (Position) Gain

Position Error is multiplied by the Position Loop Proportional Gain, or Pos P Gain, to produce a component to the Velocity Command that ultimately attempts to correct for the position error. Too little Pos P Gain results in excessively compliant, or mushy, axis behavior. Too large a Pos P Gain, on the other hand, can result in axis oscillation due to classical servo instability.

> **Note:** To set the gain manually, you must first set the Torque scaling in the Output tab of this dialog.

If you know the desired loop gain in inches per minute per mil or millimeters per minute per mil, use the following formula to calculate the corresponding P gain:

Pos P Gain = 16.667 * Desired Loop Gain (IPM/mil)

If you know the desired unity gain bandwidth of the position servo in Hertz, use the following formula to calculate the corresponding P gain:

Pos P Gain = Bandwidth (Hertz) * 6.28

The typical value for the Position Proportional Gain is ~100 Sec-1.

Integral (Position) Gain

The Integral (i.e., summation) of Position Error is multiplied by the Position Loop Integral Gain, or Pos I Gain, to produce a component to the Velocity Command that ultimately attempts to correct for the position error. Pos I Gain improves the steady-state positioning performance of the system. Increasing the integral gain generally increases the ultimate positioning accuracy of the system. Excessive integral gain, however, results in system instability.

In certain cases, Pos I Gain control is disabled. One such case is when the servo output to the axis' drive is saturated. Continuing integral control behavior in this case would only exacerbate the situation. When the Integrator Hold parameter is set to Enabled, the servo loop automatically disables the integrator during commanded motion.

While the Pos I Gain, if employed, is typically established by the automatic servo tuning procedure (in the Tuning tab of this dialog), the Pos I Gain value may also be set manually. Before doing this it must be stressed that the Torque Scaling factor for the axis must be established for the drive system (in the Output tab of this dialog box). Once this is done, the Pos I Gain can be computed based on the current or computed value for the Pos P Gain using the following formula:

Pos I Gain = .025 * 0.001 Sec/mSec * (Pos P Gain)2

Assuming a Pos P Gain value of 100 Sec-1 this results in a Pos I Gain value of 2.5 ~0.1 mSec-1 - Sec-1.

Proportional (Velocity) Gain

Note: This parameter is enabled only for external drives configured for Torque loop operation in the Servo tab.

Velocity Error is multiplied by the Velocity Proportional Gain to produce a component to the Torque Command that ultimately attempts to correct for the velocity error, creating a damping effect. Thus, increasing the Velocity Proportional Gain results in smoother motion, enhanced acceleration, reduced overshoot, and greater system stability. However, too much Velocity Proportional Gain leads to high frequency instability and resonance effects.

If you know the desired unity gain bandwidth of the velocity servo in Hertz, you can use the following formula to calculate the corresponding P gain.

Vel P Gain = Bandwidth (Hertz) / 6.28

The typical value for the Velocity Proportional Gain is ~250 mSec-1.

Integral (Velocity) Gain

Note: This parameter is enabled only for external drives configured for Torque loop operation in the Servo tab.

At every servo update the current Velocity Error is accumulated in a variable called the Velocity Integral Error. This value is multiplied by the Velocity Integral Gain to produce a component to the Torque

Command that attempts to correct for the velocity error. The higher the Vel I Gain value, the faster the axis is driven to the zero Velocity Error condition. Unfortunately, I Gain control is intrinsically unstable. Too much I Gain results in axis oscillation and servo instability.

In certain cases, Vel I Gain control is disabled. One such case is when the servo output to the axis' drive is saturated. Continuing integral control behavior in this case would only exacerbate the situation. When the Integrator Hold parameter is set to Enabled, the servo loop automatically disables the integrator during commanded motion.

Due to the destabilizing nature of Integral Gain, it is recommended that Position Integral Gain and Velocity Integral Gain be considered mutually exclusive. If Integral Gain is needed for the application, use one or the other, but not both. In general, where static positioning accuracy is required, Position Integral Gain is the better choice.

While the Vel I Gain, if employed, is typically established by the automatic servo tuning procedure (in the Tune tab of this dialog box), the Pos I Gain value may also be set manually. Before doing this it must be stressed that the Torque Scaling factor for the axis must be established for the drive system, in the Output tab. Once this is done the Vel I Gain can be computed based on the current or computed value for the Vel P Gain using the following formula:

$$\text{Vel I Gain} = 0.25 * 0.001 \text{ Sec/mSec} * (\text{Vel P Gain})2$$

The typical value for the Velocity Proportional Gain is ~15 mSec-2.

Integrator Hold

If the Integrator Hold parameter is set to:

- Enabled, the servo loop temporarily disables any enabled position or velocity integrators while the command position is changing. This feature is used by point-to-point moves to minimize the integrator wind-up during motion.
- Disabled, all active position or velocity integrators are always enabled.

Manual Adjust

Click on this button to access the Gains tab of the Manual Adjust dialog for online editing.

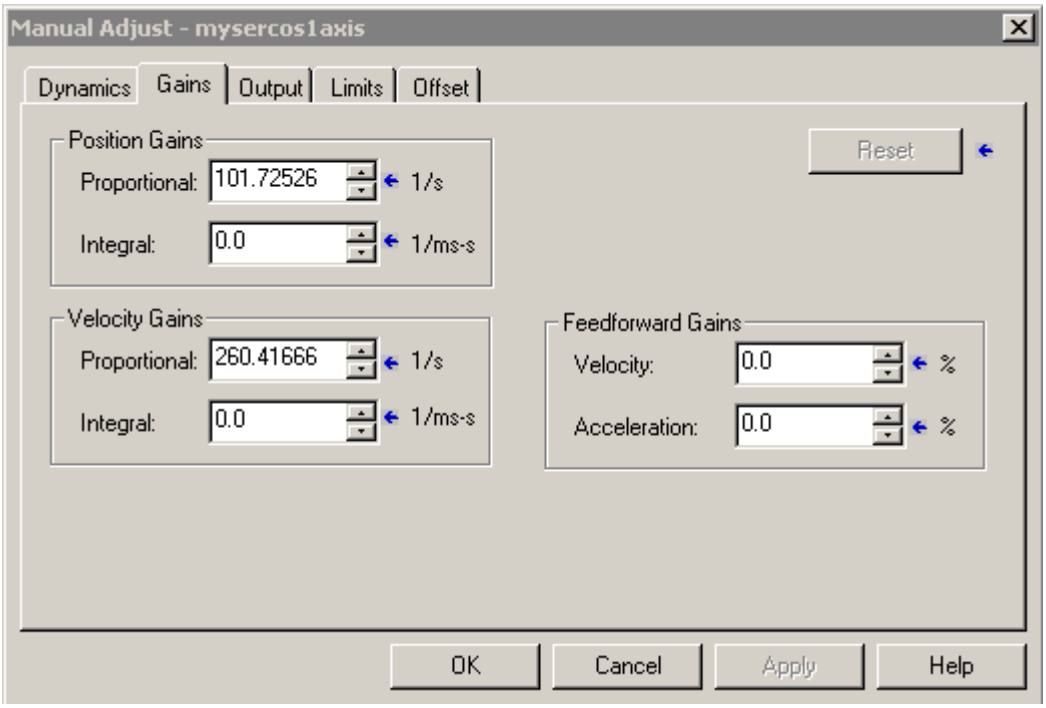


Figure 6.35 Axis Properties - Gains Tab Manual Adjust Screen for Axis_Servo_Drive

Note: The Manual Adjust button is disabled when RSLogix 5000 is in Wizard mode, and when you have not yet saved or applied your offline edits to the above parameters.

Set Custom Gains

Click on this button to open the Custom Gain Attributes dialog.

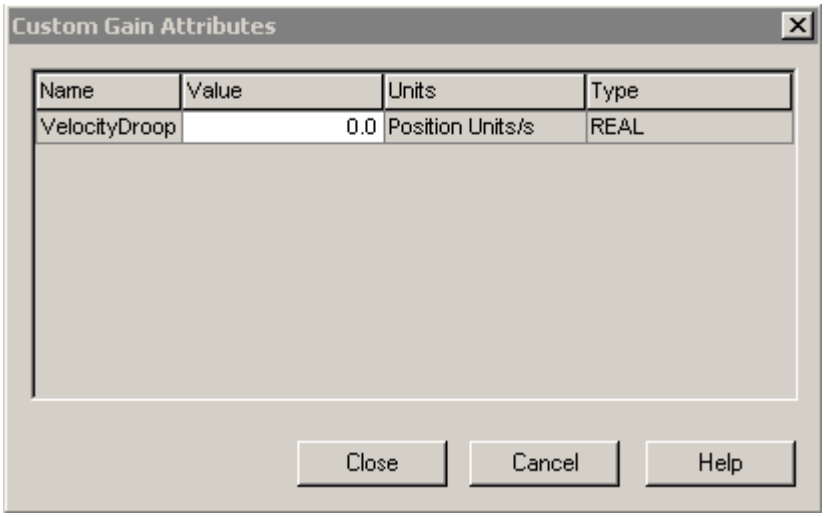


Figure 6.36 Set Custom Gains Dialog from Gains Tab for AXIS_SERVO_DRIVE

At this dialog box you can edit the VelocityDroop attribute.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Attribute

The following attribute value can be monitored and edited in this dialog box.

Attribute	Description
VelocityDroop	This 32-bit unsigned attribute – also referred to as "static gain" – acts as a very slow discharge of the velocity loop integrator. VelocityDroop may be used as a component of an external position loop system where setting this parameter to a higher, non-zero value eliminates servo hunting due to load/stick friction effects. This parameter only has effect if VelocityIntegralGain is not zero. Its value ranges from 0 to 2.14748x10^12. **Note:** This value is not applicable for Ultra3000 drives.

Output Tab - AXIS_SERVO

Use this dialog for offline configuration of:

- scaling values, which are used to generate gains, and
- the servo's low-pass digital output filter

for an axis of the type AXIS_SERVO configured as a Servo drive in the General tab of this dialog.

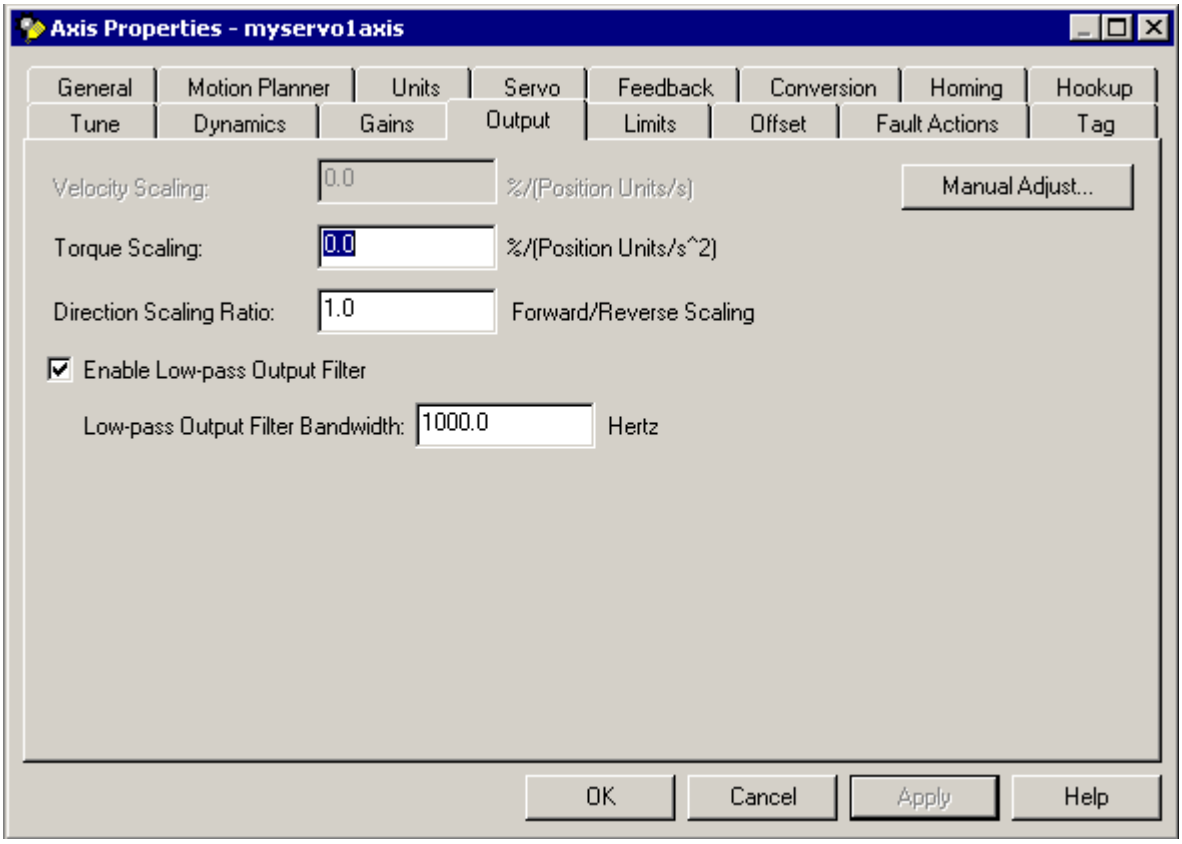


Figure 6.37 Axis Properties - Output Tab for Axis_Servo

The parameters on this tab can be edited in either of two ways:

- edit on this tab by typing your parameter changes and then clicking on OK or Apply to save your edits
- edit in the Manual Adjust dialog: click on the Manual Adjust button to open the Manual Adjust dialog to this tab and use the spin controls to edit parameter settings. Your changes are saved the moment a spin control changes any parameter value.

  Note: The parameters on this tab become read-only and cannot be edited when the controller is online if the controller is set to Hard Run mode, or if a Feedback On condition exists.

When RSLogix 5000 is offline, the following parameters can be edited and the program saved to disk using either the Save command or by clicking on the Apply button. You must re-download the edited program to the controller before it can be run.

Velocity Scaling

The Velocity Scaling attribute is used to convert the output of the servo loop into equivalent voltage to an external velocity servo drive. This has the effect of "normalizing" the units of the servo loop gain parameters so that their values are not affected by variations in feedback resolution, drive scaling, or mechanical gear ratios. The Velocity Scaling value is typically established by servo's automatic tuning procedure but these values can be calculated, if necessary, using the following guidelines.

If the axis is configured for a velocity external servo drive (in the Servo tab of this dialog), the software velocity loop in the servo module is disabled. In this case the Velocity Scaling value can be calculated by the following formula:

Velocity Scaling = 100% / (Speed @ 100%)

For example, if this axis is using position units of motor revolutions (revs), and the servo drive is scaled such that with an input of 100% (e.g. 10 Volts) the motor goes 5,000 RPM (or 83.3 RPS), the Velocity Scaling attribute value would be calculated as:

Velocity Scaling = 100% / (83.3 RPS) = 1.2% / Revs Per Second

Torque Scaling

The Torque Scaling attribute is used to convert the acceleration of the servo loop into equivalent % rated torque to the motor. This has the effect of "normalizing" the units of the servo loops gain parameters so that their values are not affected by variations in feedback resolution, drive scaling, motor and load inertia, and mechanical gear ratios. The Torque Scaling value is typically established by the controller's automatic tuning procedure but the value can be manually calculated, if necessary, using the following guidelines:

Torque Scaling = 100% Rated Torque / (Acceleration @ 100% Rated Torque)

For example, if this axis is using position units of motor revolutions (revs), with 100% rated torque applied to the motor, if the motor accelerates at a rate of 3000 Revs/Sec2, the Torque Scaling attribute value would be calculated as shown below:

Torque Scaling = 100% Rated / (3000 RPS2) = 0.0333% Rated/ Revs Per Second2

> **Note:** If the Torque Scaling value does not reflect the true torque to acceleration characteristic of the system, the gains also does not reflect the true performance of the system.

Enable Low-pass Output Filter

Select this to enable the servo's low-pass digital output filter. De-select this to disable this filter.

> **Note:** During tuning, if the controller detects a high degree of tuning inertia, it enables the Low Pass Output Filter and calculates and sets a value for Low Pass Output Filter Bandwidth.

Low-pass Output Filter Bandwidth

With Enable Low-pass Output Filter selected, this value sets the bandwidth, in Hertz, of the servo's low-pass digital output filter. Use this output filter to filter out high frequency variation of the servo module output to the drive. All output from the servo module greater than the Filter Bandwidth setting is filtered-out, and not sent to the drive.

If the Low-pass Output Filter Bandwidth value is set to zero, the low-pass output filter is disabled. The lower the Filter Bandwidth value, the greater the attenuation of these high frequency components of the output signal. Because the low-pass filter adds lag to the servo loop, which pushes the system towards instability, decreasing the Filter Bandwidth value usually requires lowering the Position or Velocity Proportional Gain settings to maintain stability. The output filter is particularly useful in high inertia applications where resonance behavior can severely restrict the maximum bandwidth capability of the servo loop.

Manual Adjust

Click on this button to access the Output tab of the Manual Adjust dialog for online editing.

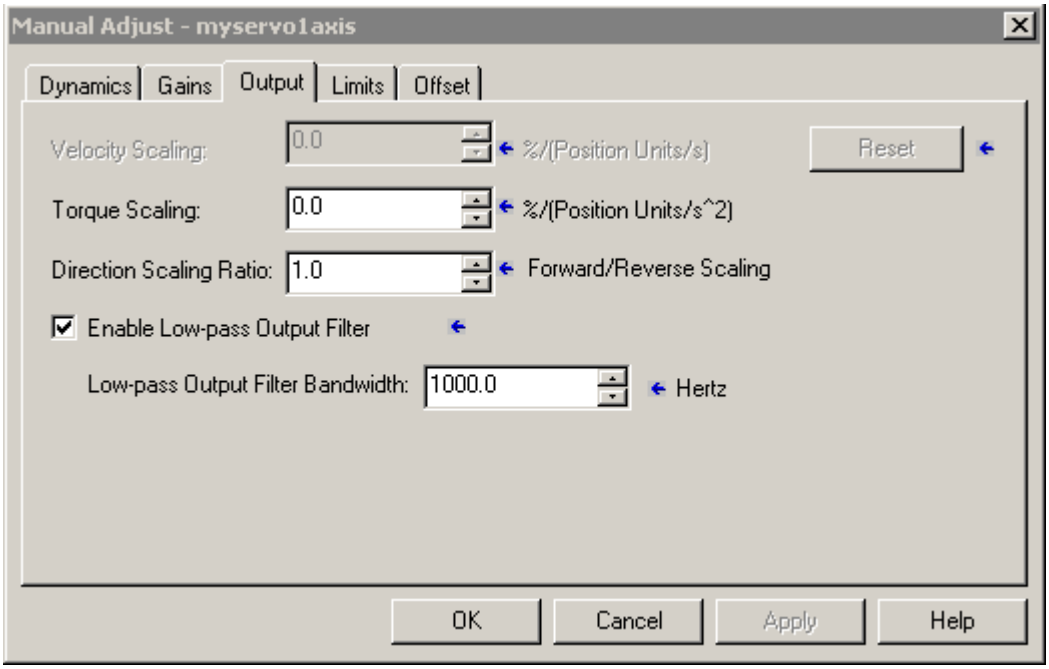


Figure 6.38 Axis Properties - Output Tab Manual Adjust Screen for Axis_Servo

Note: The Manual Adjust button is disabled when RSLogix 5000 is in Wizard mode, and when you have not yet saved or applied your offline edits to the above parameters.

Output Tab Overview - AXIS_SERVO_DRIVE

Use this dialog box to make the following offline configurations:

- set the torque scaling value, which is used to generate gains
- enable and configure the Notch Filter
- enable and configure servo's low-pass digital output filter

for an axis of the type AXIS_SERVO_DRIVE, configured as a Servo drive in the General tab of this dialog.

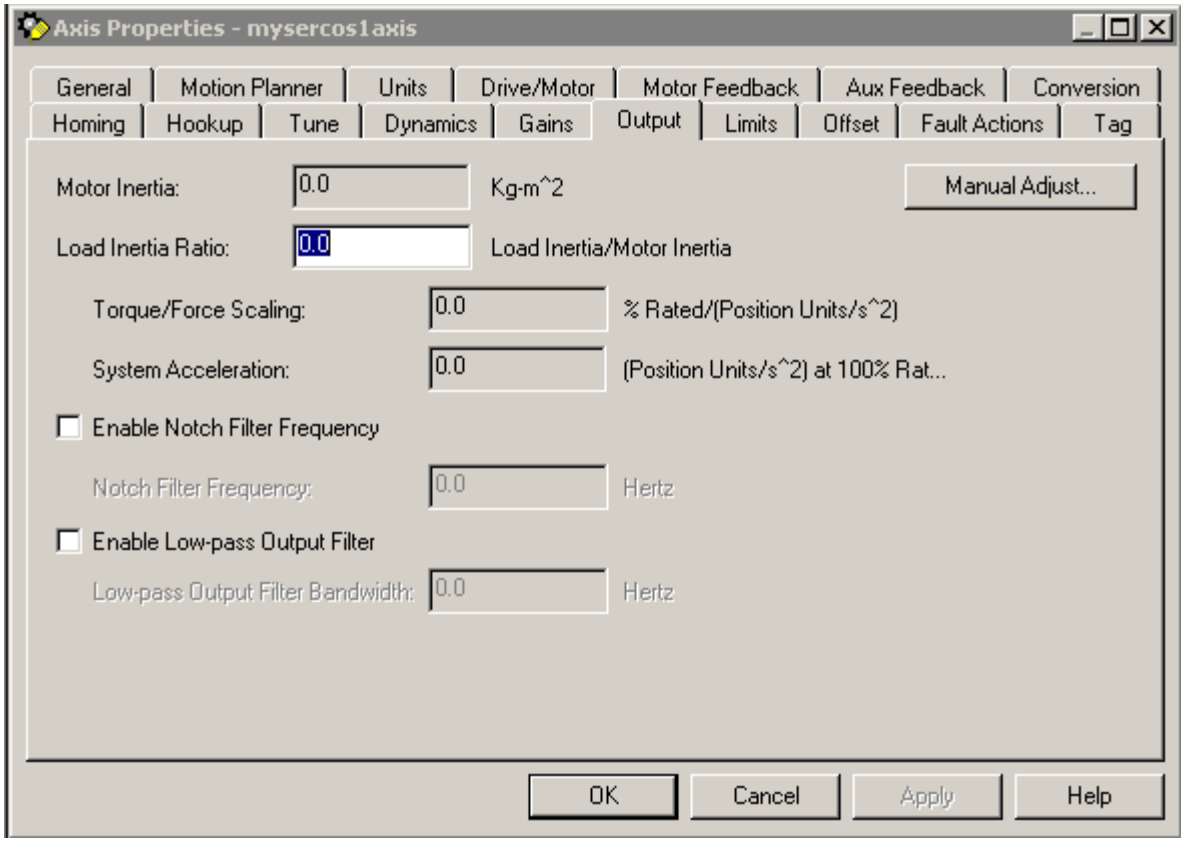


Figure 6.39 Axis Properties - Output Tab for Axis_Servo_Drive

The parameters on this tab can be edited in either of two ways:

- edit on this tab by typing your parameter changes and then clicking on OK or Apply to save your edits
- edit in the Manual Adjust dialog: click on the Manual Adjust button to open the Manual Adjust dialog to this tab and use the spin controls to edit parameter settings. Your changes are saved the moment a spin control changes any parameter value.

  Note: The parameters on this tab become read-only and cannot be edited when the controller is online if the controller is set to Hard Run mode, or if a Feedback On condition exists.

When RSLogix 5000 is offline, the following parameters can be edited and the program saved to disk using either the Save command or by clicking on the Apply button. You must re-download the edited program to the controller before it can be run.

Motor Inertia

The Motor Inertia value represents the inertia of the motor without any load attached to the motor shaft in Torque Scaling units.

Load Inertia Ratio

The Load Inertia Ratio value represents the ratio of the load inertia to the motor inertia.

Torque Scaling

The Torque Scaling attribute is used to convert the acceleration of the servo loop into equivalent % rated torque to the motor. This has the effect of "normalizing" the units of the servo loops gain parameters so that their values are not affected by variations in feedback resolution, drive scaling, motor and load inertia, and mechanical gear ratios. The Torque Scaling value is typically established by the controller's automatic tuning procedure but the value can be manually calculated, if necessary, using the following guidelines:

> Torque Scaling = 100% Rated Torque / (Acceleration @ 100% Rated Torque)

For example, if this axis is using position units of motor revolutions (revs), with 100% rated torque applied to the motor, if the motor accelerates at a rate of 3000 Revs/Sec2, the Torque Scaling attribute value would be calculated as shown below:

Torque Scaling = 100% Rated / (3000 RPS2) = 0.0333% Rated/ Revs Per Second2

> **Note:** If the Torque Scaling value does not reflect the true torque to acceleration characteristic of the system, the gains also do not reflect the true performance of the system.

Enable Notch Filter

Select this to enable the drive's notch filter. De-select this to disable this filter.

Notch Filter

With Enable Notch Filter selected, this value sets the center frequency of the drive's digital notch filter. If the Notch Filter value is set to zero, the notch filter is disabled.

Currently implemented as a 2nd order digital filter with a fixed Q, the Notch Filter provides approximately 40DB of output attenuation at the

Notch Filter frequency. This output notch filter is particularly useful in attenuating mechanical resonance phenomena. The output filter is particularly useful in high inertia applications where mechanical resonance behavior can severely restrict the maximum bandwidth capability of the servo loop.

Note: This value is not applicable for Ultra3000 drives.

Enable Low-pass Output Filter

Select this to enable the servo's low-pass digital output filter. De-select this to disable this filter.

Note: During tuning, if the controller detects a high degree of tuning inertia, the controller enables the Low Pass Output Filter and calculates and sets a value for Low Pass Output Filter Bandwidth.

Low-pass Output Filter Bandwidth

With Enable Low-pass Output Filter selected, this value sets the bandwidth, in Hertz, of the servo's low-pass digital output filter. Use this output filter to filter out high frequency variation of the servo module output to the drive. All output from the servo module greater than the Filter Bandwidth setting is filtered-out, and not sent to the drive.

If the Low-pass Output Filter Bandwidth value is set to zero, the low-pass output filter is disabled. The lower the Filter Bandwidth value, the greater the attenuation of these high frequency components of the output signal. Because the low-pass filter adds lag to the servo loop, which pushes the system towards instability, decreasing the Filter Bandwidth value usually requires lowering the Position or Velocity Proportional Gain settings to maintain stability. The output filter is particularly useful in high inertia applications where resonance behavior can severely restrict the maximum bandwidth capability of the servo loop.

Manual Adjust

Click on this button to open the Output tab of the Manual Adjust dialog for online editing of Torque/Force Scaling, the Notch Filter Frequency, and the Low-pass Output Filter parameters.

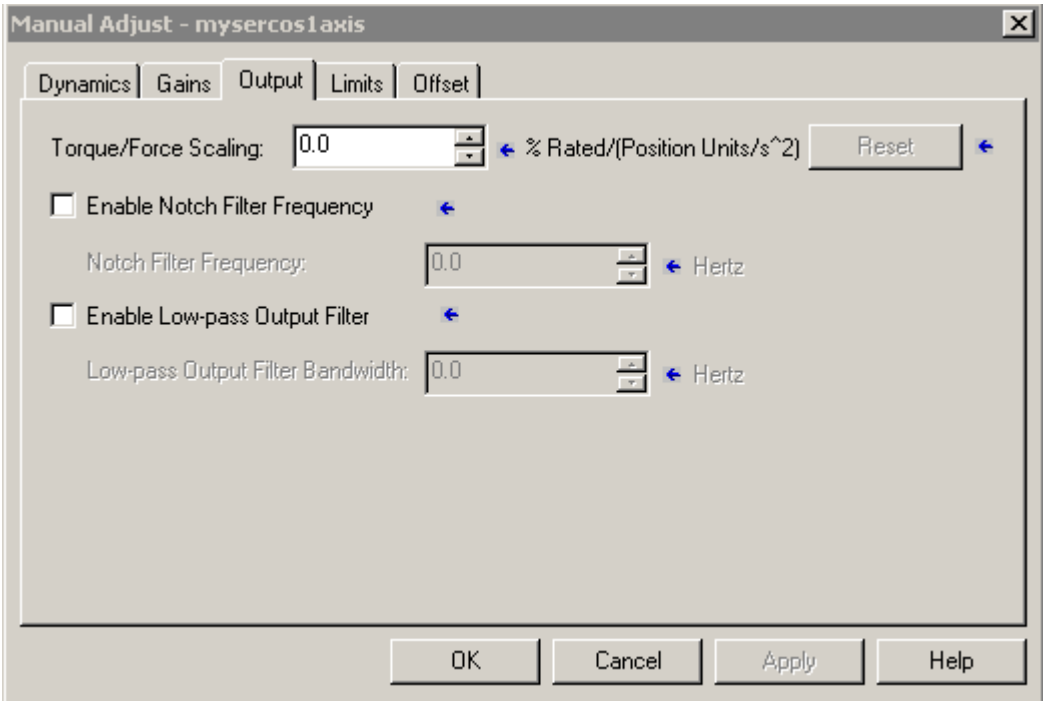


Figure 6.40 Axis Properties - Output Tab for Axis_Servo_Drive

Note: The Manual Adjust button is disabled when RSLogix 5000 is in Wizard mode, and when offline edits to the above parameters have not yet been saved or applied.

Limits Tab - AXIS_SERVO

Use this tab to make the following offline configurations:

- enable and set maximum positive and negative software travel limits, and
- configure both Position Error Tolerance and Position Lock Tolerance, and
- set the servo drive's Output Limit

for an axis of the type AXIS_SERVO configured as a Servo drive in the General tab of this dialog.

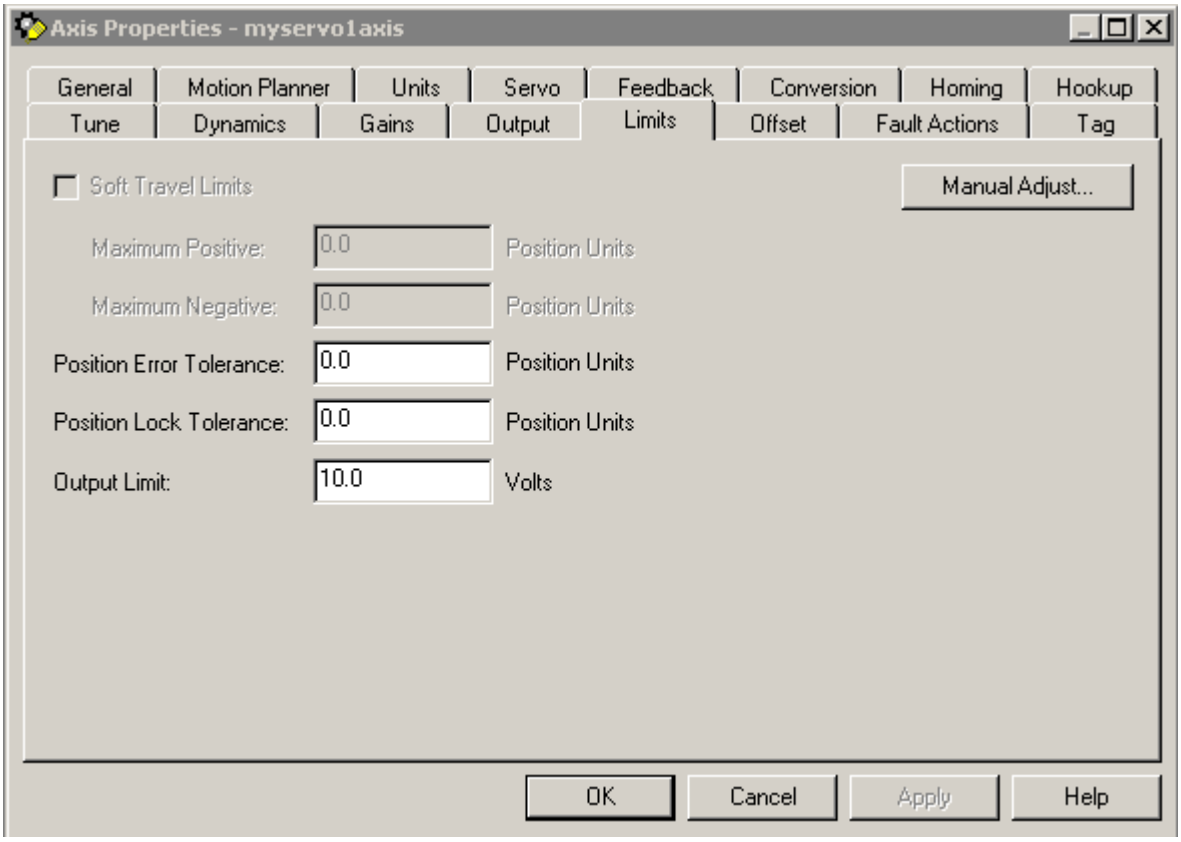


Figure 6.41 Axis Properties - Limits Tab for Axis_Servo

The parameters on this tab can be edited in either of two ways:

- edit on this tab by typing your parameter changes and then clicking on OK or Apply to save your edits
- edit in the Manual Adjust dialog: click on the Manual Adjust button to open the Manual Adjust dialog to this tab and use the spin controls to edit parameter settings. Your changes are saved the moment a spin control changes any parameter value.

  Note: The parameters on this tab become read-only and cannot be edited when the controller is online if the controller is set to Hard Run mode, or if a Feedback On condition exists.

When RSLogix 5000 is offline, the following parameters can be edited and the program saved to disk using either the Save command or by clicking on the Apply button. You must re-download the edited program to the controller before it can be run.

Soft Travel Limits

Enables software overtravel checking for an axis when Positioning Mode is set to Linear (in the Conversion tab of this dialog). If an axis is configured for software overtravel limits and if that axis passes beyond these maximum travel limits (positive or negative), a software overtravel fault is issued. The response to this fault is specified by the Soft Overtravel setting (in the Fault Actions tab of this dialog). Software overtravel limits are disabled during the tuning process.

Maximum Positive

Type the maximum positive position to be used for software overtravel checking, in position units.

> **Note:** The Maximum Positive limit must always be greater than the Maximum Negative limit.

Maximum Negative

Type the maximum negative position to be used for software overtravel checking, in position units.

> **Note:** The Maximum Negative limit must always be less than the Maximum Positive limit.

Position Error Tolerance

Specifies how much position error the servo tolerates before issuing a position error fault. This value is interpreted as a +/- quantity.

For example, setting Position Error Tolerance to 0.75 position units means that a position error fault is generated whenever the position error of the axis is greater than 0.75 or less than -0.75 position units, as shown here:

> **Note:** This value is set to twice the following error at maximum speed based on the measured response of the axis, during the autotuning process. In most applications, this value provides reasonable protection in case of an axis fault or stall condition without nuisance faults during normal operation. If you need to change the calculated position error tolerance value, the recommended setting is 150% to 200% of the position error while the axis is running at its maximum speed.

Position Lock Tolerance

Specifies the maximum position error the servo module accepts in order to indicate the Position Lock status bit is set. This is useful in

determining when the desired end position is reached for position moves. This value is interpreted as a +/- quantity.

For example, specifying a lock tolerance of 0.01 provides a minimum positioning accuracy of +/- 0.01 position units, as shown here:

Output Limit

Provides a method of limiting the maximum servo output voltage of a physical axis to a specified level. The servo output for the axis as a function of position servo error, both with and without servo output limiting, is shown below.

The servo output limit may be used as a software current or torque limit if you are using a servo drive in torque loop mode. The percentage of the drive's maximum current that the servo controller ever commands is equal to the specified servo output limit. For example, if the drive is capable of 30 Amps of current for a 10 Volt input, setting the servo output limit to 5V limits the maximum drive current to 15 Amps.

The servo output limit may also be used if the drive cannot accept the full ±10 Volt range of the servo output. In this case, the servo output limit value effectively limits the maximum command sent to the amplifier. For example, if the drive can only accept command signals up to ±7.5 Volts, set the servo output limit value to 7.5 volts.

Manual Adjust

Click on this button to open the Limits tab of the Manual Adjust dialog for online editing of the Position Error Tolerance, Position Lock Tolerance, and Output Limit parameters.

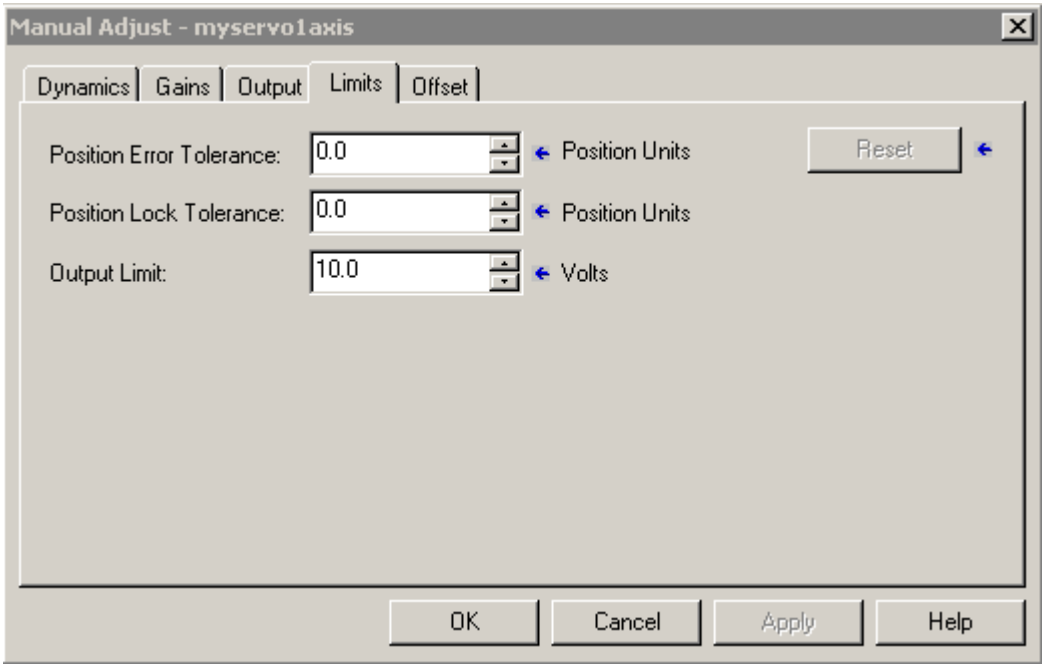


Figure 6.42 Axis Properties - Limits Tab Manual Adjust Screen for Axis_Servo

Note: The Manual Adjust button is disabled when RSLogix 5000 is in Wizard mode, and when offline edits to the above parameters have not yet been saved or applied.

Limits Tab - AXIS_SERVO_DRIVE

Use this tab to make the following offline configurations:

- enable and set maximum positive and negative software travel limits, and
- configure both Position Error Tolerance and Position Lock Tolerance,

for an axis of the type AXIS_SERVO_DRIVE configured as a Servo drive in the General tab of this dialog.

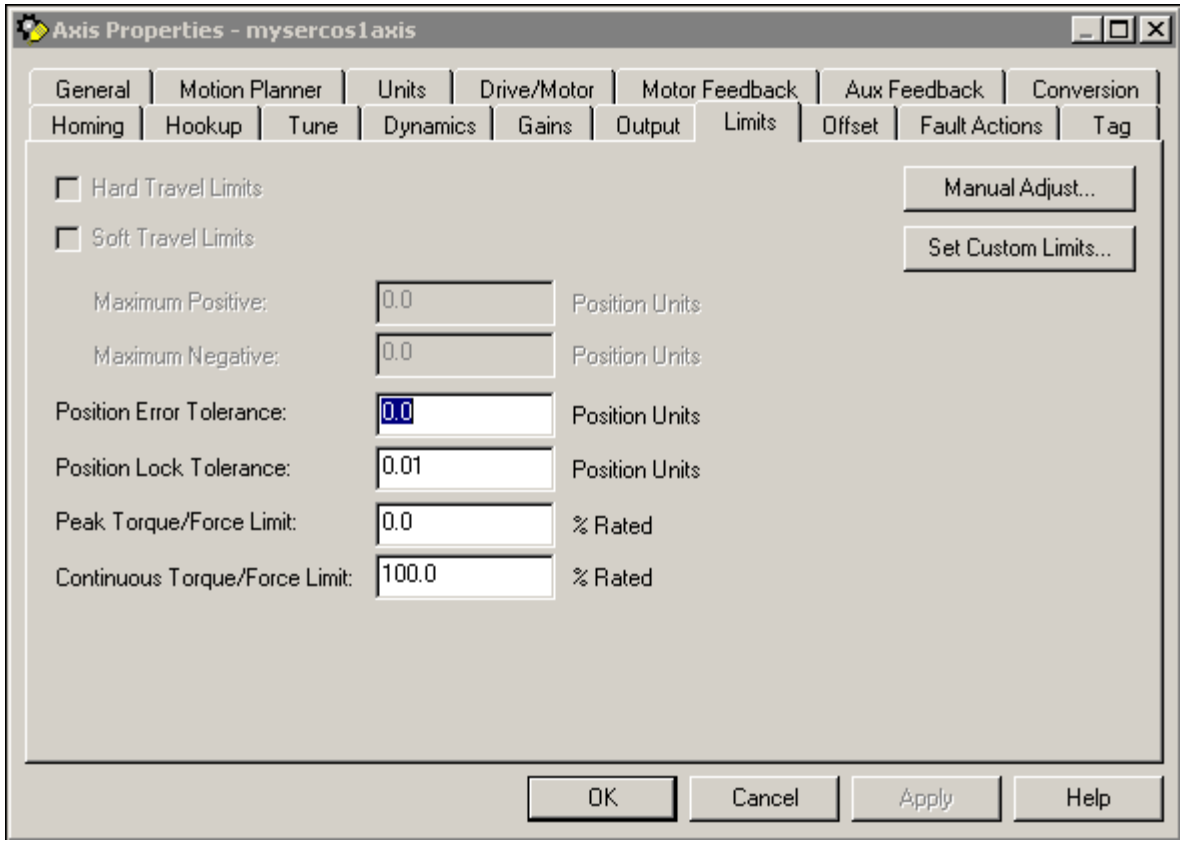


Figure 6.43 Axis Properties - Limits Tab for Axis_Servo_Drive

The parameters on this tab can be edited in either of two ways:

- edit on this tab by typing your parameter changes and then clicking on OK or Apply to save your edits
- edit in the Manual Adjust dialog: click on the Manual Adjust button to open the Manual Adjust dialog to this tab and use the spin controls to edit parameter settings. Your changes are saved the moment a spin control changes any parameter value.

  Note: The parameters on this tab become read-only and cannot be edited when the controller is online if the controller is set to Hard Run mode, or if a Feedback On condition exists.

When RSLogix 5000 is offline, the following parameters can be edited and the program saved to disk using either the Save command or by clicking on the Apply button. You must re-download the edited program to the controller before it can be run.

Hard Travel Limits

Enables a periodic test that monitors the current state of the positive and negative overtravel limit switch inputs, when Positioning Mode is set to Linear (in the Conversion tab of this dialog). If an axis is configured for hardware overtravel checking and if that axis passes beyond a positive or negative overtravel limit switch, a Positive Hard Overtravel Fault or Negative Hard Overtravel Fault is issued. The response to this fault is specified by the Hard Overtravel setting (in the Fault Actions tab of this dialog).

Soft Travel Limits

Enables software overtravel checking for an axis when Positioning Mode is set to Linear (in the Conversion tab of this dialog). If an axis is configured for software overtravel limits and if that axis passes beyond these maximum travel limits (positive or negative), a software overtravel fault is issued. The response to this fault is specified by the Soft Overtravel setting (in the Fault Actions tab of this dialog). Software overtravel limits are disabled during the tuning process.

Maximum Positive

Type the maximum positive position to be used for software overtravel checking, in position units.

> **Note:** The Maximum Positive limit must always be greater than the Maximum Negative limit.

Maximum Negative

Type the maximum negative position to be used for software overtravel checking, in position units.

> **Note:** The Maximum Negative limit must always be less than the Maximum Positive limit.

Position Error Tolerance

Specifies how much position error the servo tolerates before issuing a position error fault. This value is interpreted as a +/- quantity.

For example, setting Position Error Tolerance to 0.75 position units means that a position error fault is generated whenever the position error of the axis is greater than 0.75 or less than -0.75 position units, as shown here:

> **Note:** This value is set to twice the following error at maximum speed based on the measured response of the axis, during the

autotuning process. In most applications, this value provides reasonable protection in case of an axis fault or stall condition without nuisance faults during normal operation. If you need to change the calculated position error tolerance value, the recommended setting is 150% to 200% of the position error while the axis is running at its maximum speed.

Position Lock Tolerance

Specifies the maximum position error the servo module accepts in order to indicate the Position Lock status bit is set. This is useful in determining when the desired end position is reached for position moves. This value is interpreted as a +/- quantity.

For example, specifying a lock tolerance of 0.01 provides a minimum positioning accuracy of +/- 0.01 position units, as shown here:

Peak Torque/Force Limit

The Peak Torque/Force Limit specifies the maximum percentage of the motors rated current that the drive can command as either positive or negative torque/force. For example, a torque limit of 150% shall limit the current delivered to the motor to 1.5 times the continuous current rating of the motor.

Continuous Torque/Force Limit

The Continuous Torque/Force Limit specifies the maximum percentage of the motors rated current that the drive can command on a continuous or RMS basis. For example, a Continuous Torque/Force Limit of 150% limits the continuous current delivered to the motor to 1.5 times the continuous current rating of the motor.

Manual Adjust

Click on this button to open the Limits tab of the Manual Adjust dialog for online editing of the Position Error Tolerance, Position Lock

Tolerance, Peak Torque/Force Limit, and Continuous Torque/Force Limit parameters.

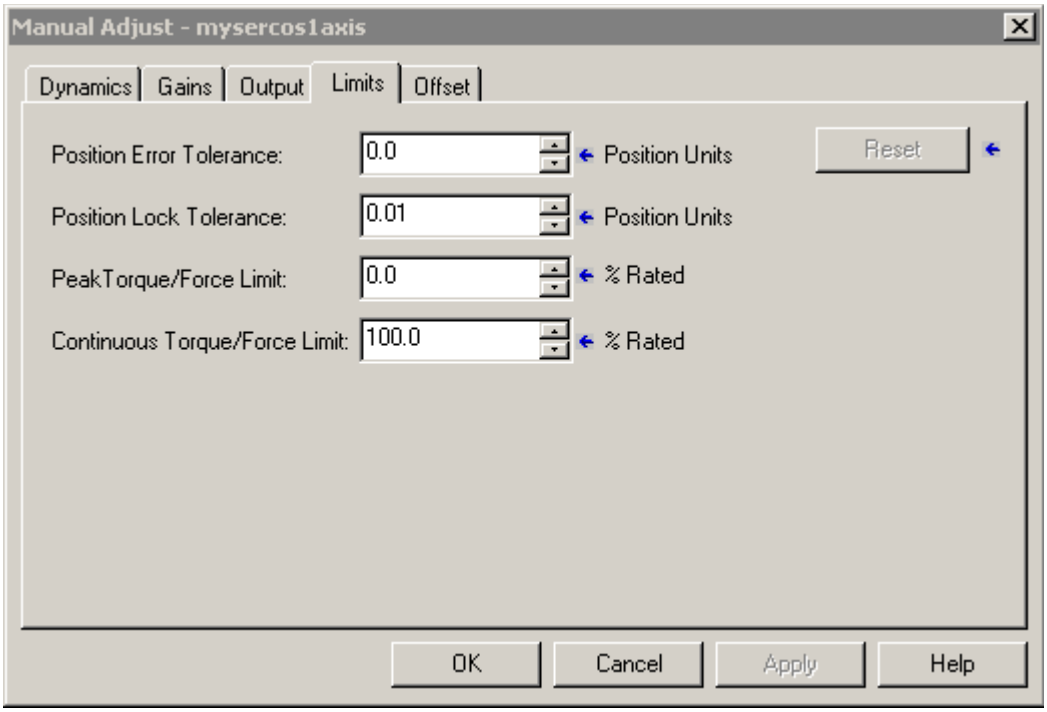


Figure 6.44 Axis Properties - Limits Tab for Axis_Servo_Drive

Note: The Manual Adjust button is disabled when RSLogix 5000 is in Wizard mode, and when offline edits to the above parameters have not yet been saved or applied.

Set Custom Limits

Click this button to open the Custom Limit Attributes dialog.

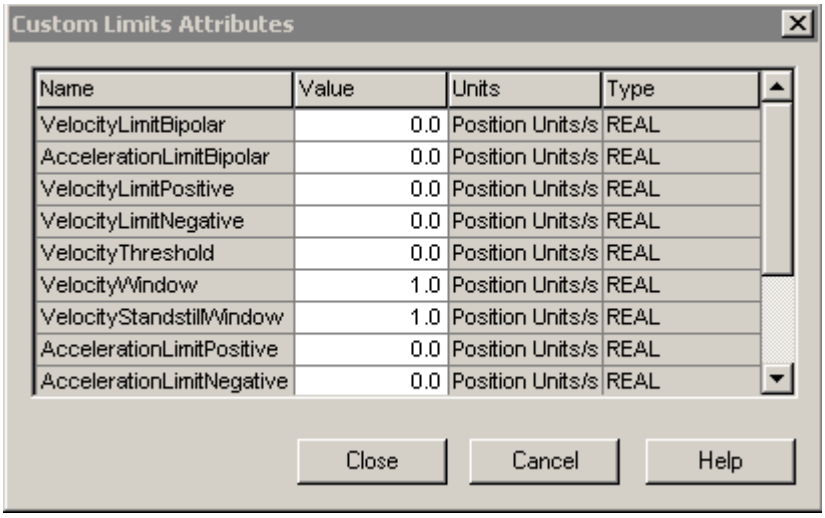


Figure 6.45 Set Custom Limits Dialog from the Limits Tab for the AXIS_SERVO_DRIVE

From this dialog box you can monitor and edit the limit-related attributes.

When RSLogix 5000 software is online, the parameters on this tab transition to a read-only state. When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Attributes

The following attribute values can be monitored and edited in this dialog box.

Attribute	Description
VelocityLimitBipolar	This attribute sets the velocity limit symmetrically in both directions. If the command velocity exceeds this value, VelocityLimitStatusBit of the DriveStatus attribute is set. This attribute has a value range of 0 to $2.14748x10^{12}$.
AccelerationLimitBipolar	This attribute sets the acceleration and deceleration limits for the drive. If the command acceleration exceeds this value, AccelLimitStatusBit of the DriveStatus attribute is set. This attribute has a value range of 0 to $2.14748x10^{15}$.
TorqueLimitBipolar	This attribute sets the torque limit symmetrically in both directions. When actual torque exceeds this value TorqueLimitStatus of the DriveStatus attribute is set. This attribute has a value range of 0 to 1000.
VelocityLimitPositive	This attribute displays the maximum allowable velocity in the positive direction. If the velocity limit is exceeded, bit 5 ("Velocity Command Above Velocity Limit") VelocityLimitStatusBit of the DriveStatus attribute is set. This attribute has a value range of 0 to $2.14748x10^{12}$.

Attribute	Description
VelocityLimitNegative	This attribute displays the maximum allowable velocity in the negative direction. If the velocity limit is exceeded, bit 5 ("Velocity Command Above Velocity Limit") VelocityLimitStatusBit of the DriveStatus attribute is set. This attribute has a value range of $-2.14748x10^{12}$ to 0.
VelocityThreshold	This attribute displays the velocity threshold limit. If the motor velocity is less than this limit, VelocityThresholdStatus of the DriveStatus attribute is set. This attribute has a value range of 0 to $2.14748x10^{12}$.
VelocityWindow	This attribute displays the limits of the velocity window. If the motor's actual velocity differs from the command velocity by an amount less that this limit VelocityLockStatus of the DriveStatus attribute is set. This attribute has a value range of 0 to $2.14748x10^{12}$.
VelocityStandstillWindow	This attribute displays the velocity limit for the standstill window. If the motor velocity is less than this limit VelocityStandStillStatus of the DriveStatus bit is set. This attribute has a value range of 0 to $2.14748x10^{12}$.
AccelerationLimitPositive	This attribute limits the maximum acceleration ability of the drive to the programmed value. If the command acceleration exceeds this value, AccelLimitStatusBit of the DriveStatus attribute is set. This attribute has a value range of 0 to $2.14748x10^{15}$.
AccelerationLimitNegative	This attribute limits the maximum acceleration ability of the drive to the programmed value. If the command acceleration exceeds this value, the AccelLimitStatus bit of the DriveStatus attribute is set. This attribute has a value range of $-2.14748x10^{15}$ to 0.

Attribute	Description
TorqueLimitPositive	This attribute displays the maximum torque in the positive direction. If the torque limit is exceeded, the TorqueLimitStatus bit of the DriveStatus attribute is set. This attribute has a value range of 0 to 1000.
TorqueLimitNegative	This attribute displays the maximum torque in the negative direction. If the torque limit is exceeded, the TorqueLimitStatus bit of the DriveStatus attribute is set. This attribute has a value range of -1000 to 0.
TorqueThreshold	This attribute displays the torque threshold. If this limit is exceeded, the TorqueThreshold bit of the DriveStatus attribute is set. This attribute has a value range of 0 to 1000.

Offset Tab - AXIS_SERVO

Use this tab to make offline adjustments to the following Servo Output values:

- Friction Compensation
- Velocity Offset
- Torque Offset
- Output Offset

for an axis of the type AXIS_SERVO configured as a Servo drive in the General tab of this dialog.

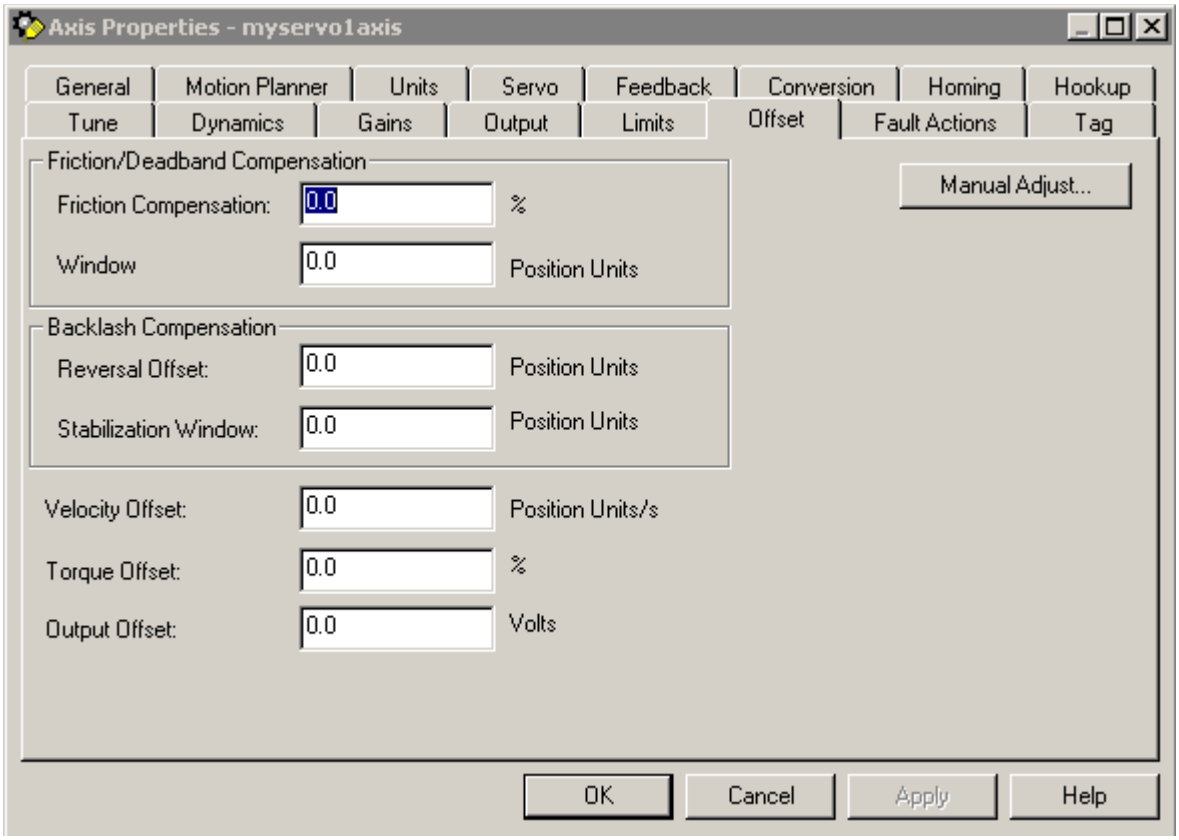


Figure 6.46 Axis Properties - Offset Tab for Axis_Servo

The parameters on this tab can be edited in either of two ways:

- edit on this tab by typing your parameter changes and then clicking on OK or Apply to save your edits
- edit in the Manual Adjust dialog: click on the Manual Adjust button to open the Manual Adjust dialog to this tab and use the spin controls to edit parameter settings. Your changes are saved the moment a spin control changes any parameter value.

  Note: The parameters on this tab become read-only and cannot be edited when the controller is online if the controller is set to Hard Run mode, or if a Feedback On condition exists.

When RSLogix 5000 is offline, the following parameters can be edited and the program saved to disk using either the Save command or by clicking on the Apply button. You must re-download the edited program to the controller before it can be run.

Friction/Deadband Compensation

Friction Compensation

The percentage of output level added to a positive current Servo Output value, or subtracted from a negative current Servo Output value, for the purpose of moving an axis that is stuck in place due to static friction.

It is not unusual for an axis to have enough static friction (called “sticktion”) that, even with a significant position error, the axis refuses to budge. Friction Compensation is used to break “sticktion” in the presence of a non-zero position error. This is done by adding, or subtracting, a percentage output level), called Friction Compensation to the Servo Output value.

The Friction Compensation value should be just less than the value that would break the “sticktion”

A larger value can cause the axis to “dither”, i.e. move rapidly back and forth about the commanded position.

Friction Compensation Window

To address the issue of dither when applying Friction Compensation and hunting from the integral gain, a Friction Compensation Window is applied around the current command position when the axis is not being commanded to move. If the actual position is within the Friction Compensation Window the Friction Compensation value is applied to the Servo Output but scaled by the ratio of the position error to the Friction Compensation Window. Within the window, the servo integrators are also disabled. Thus, once the position error reaches or exceeds the value of the Friction Compensation Window attribute, the full Friction Compensation value is applied. If the Friction Compensation Window is set to zero, this feature is effectively disabled.

A non-zero Friction Compensation Window has the effect of softening the Friction Compensation as its applied to the Servo Output and reducing the dithering effect that it can create. This generally allows higher values of Friction Compensation to be applied. Hunting is also eliminated at the cost of a small steady-state error.

Backlash Compensation

Reversal Offset

Backlash Reversal Offset provides the capability to compensate for positional inaccuracy introduced by mechanical backlash. For example, power-train type applications require a high level of

accuracy and repeatability during machining operations. Axis motion is often generated by a number of mechanical components, a motor, a gearbox, and a ball-screw that may introduce inaccuracies and that are subject to wear over their lifetime. Therefore, when an axis is commanded to reverse direction, mechanical play in the machine (through the gearing, ball-screw, etc.) may result in a small amount of motor motion without axis motion. As a result, the feedback device may indicate movement even though the axis has not physically moved.

If a value of zero is applied to the Backlash Reversal Offset, the feature is effectively disabled. Once enabled by a non-zero value, and the load is engaged by a reversal of the commanded motion, changing the Backlash Reversal Offset can cause the axis to shift as the offset correction is applied to the command position.

Stabilization Window

The Backlash Stabilization Window controls the Backlash Stabilization feature in the servo control loop.

Properly configured with a suitable value for the Backlash Stabilization Window, entirely eliminates the gearbox buzz without sacrificing any servo performance. In general, this value should be set to the measured backlash distance. A Backlash Stabilization Window value of zero effectively disables the feature.

Velocity Offset

Provides a dynamic velocity correction to the output of the position servo loop, in position units per second.

Torque Offset

Provides a dynamic torque command correction to the output of the velocity servo loop, as a percentage of velocity servo loop output.

Output Offset

Corrects the problem of axis “drift”, by adding a fixed voltage value (not to exceed ±10 Volts) to the Servo Output value. Input a value to achieve near zero drive velocity when the uncompensated Servo Output value is zero.

When interfacing an external Servo Drive – especially for velocity servo drives, it is necessary to compensate for the effect of drive offset. Cumulative offsets of the servo module’s DAC output and the Servo Drive Input result in a situation where a zero commanded Servo Output value causes the axis to “drift”. If the drift is excessive, it can

cause problems with the Hookup Diagnostic and Tuning procedures, as well as result in a steady-state non-zero position error when the servo loop is closed.

Manual Adjust

Click on this button to open the Offset tab of the Manual Adjust dialog for online editing of the Friction/Deadband Compensation, Backlash Compensation, Velocity Offset, Torque Offset, and Output Offset parameters.

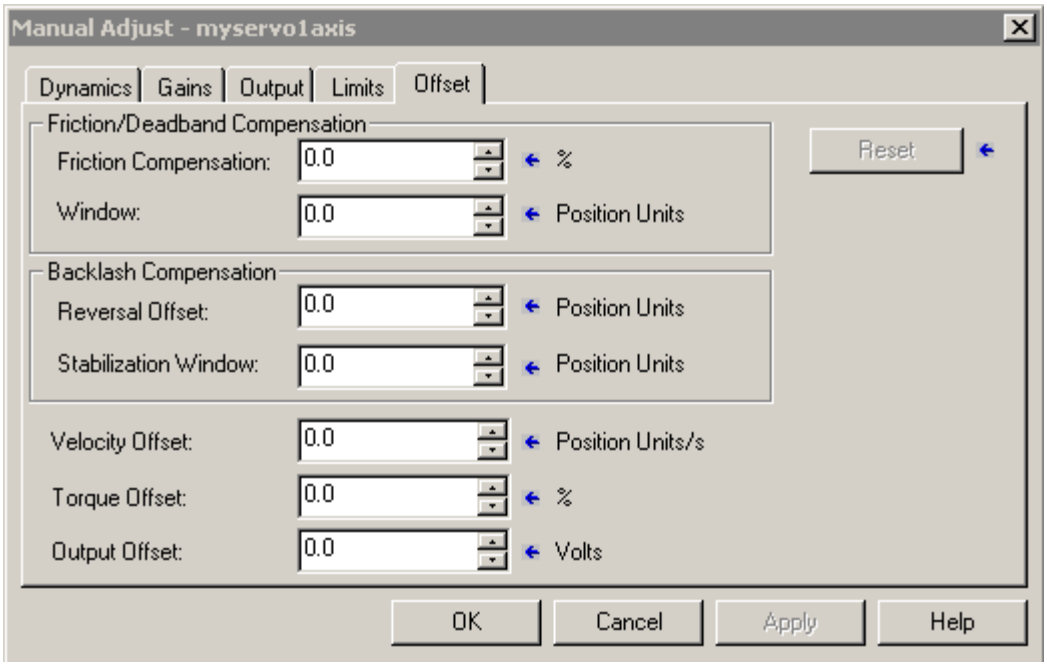


Figure 6.47 Axis Properties - Offset Tab Manual Adjust Screen for Axis_Servo

Note: The Manual Adjust button is disabled when RSLogix 5000 is in Wizard mode, and when offline edits to the above parameters have not yet been saved or applied.

Offset Tab - AXIS_SERVO_DRIVE

Use this tab to make offline adjustments to the following Servo Output values:

- Friction Compensation,
- Velocity Offset, and
- Torque Offset

for an axis of the type AXIS_SERVO_DRIVE configured as a Servo drive in the General tab of this dialog.

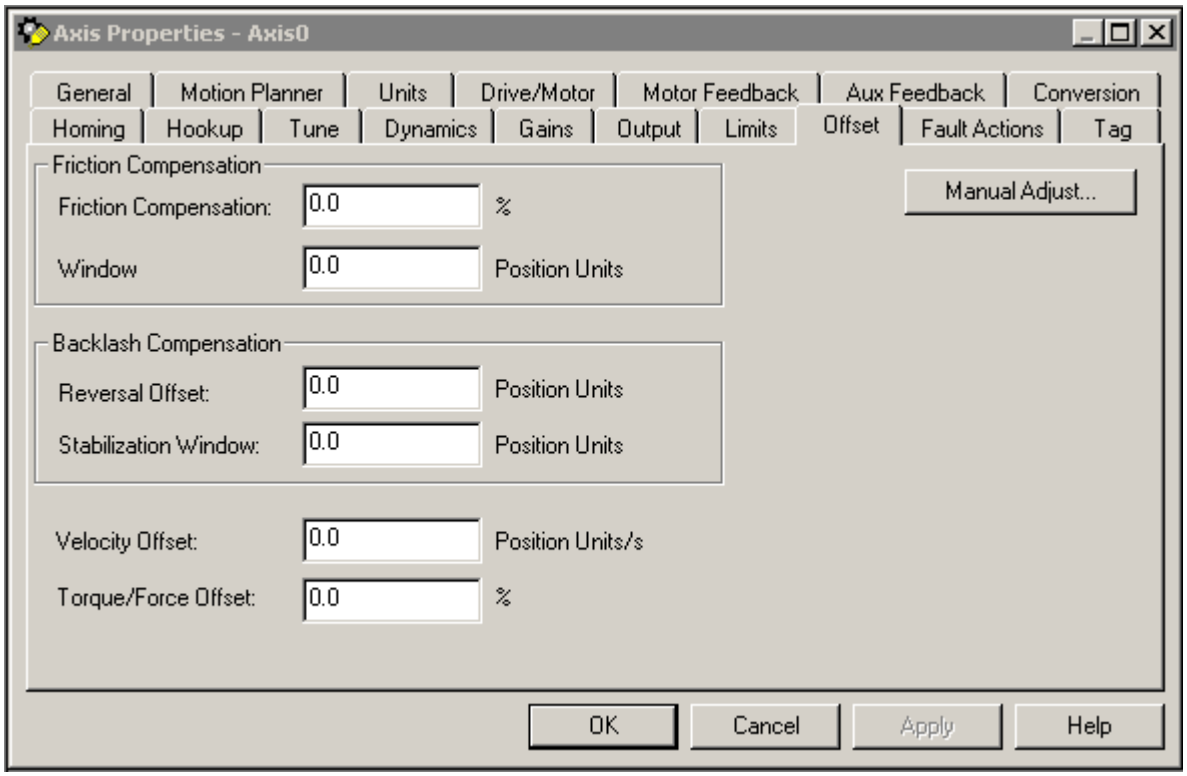


Figure 6.48 Axis Properties - Offset Tab for Axis_Servo_Drive

The parameters on this tab can be edited in either of two ways:

- edit on this tab by typing your parameter changes and then clicking on OK or Apply to save your edits
- edit in the Manual Adjust dialog: click on the Manual Adjust button to open the Manual Adjust dialog to this tab and use the spin controls to edit parameter settings. Your changes are saved the moment a spin control changes any parameter value.

  Note: The parameters on this tab become read-only and cannot be edited when the controller is online if the controller is set to Hard Run mode, or if a Feedback On condition exists.

When RSLogix 5000 is offline, the following parameters can be edited and the program saved to disk using either the Save command or by clicking on the Apply button. You must re-download the edited program to the controller before it can be run.

Friction Compensation

The percentage of output level added to a positive current Servo Output value, or subtracted from a negative current Servo Output

value, for the purpose of moving an axis that is stuck in place due to static friction.

It is not unusual for an axis to have enough static friction – called "sticktion" – that, even with a significant position error, the axis refuses to budge. Friction Compensation is used to break "sticktion" in the presence of a non-zero position error. This is done by adding, or subtracting, a percentage output level), called Friction Compensation to the Servo Output value.

The Friction Compensation value should be just less than the value that would break the “sticktion”. A larger value can cause the axis to “dither”, i.e. move rapidly back and forth about the commanded position.

Friction Compensation Window

To address the issue of dither when applying Friction Compensation and hunting from the integral gain, a Friction Compensation Window is applied around the current command position when the axis is not being commanded to move. If the actual position is within the Friction Compensation Window the Friction Compensation value is applied to the Servo Output but scaled by the ratio of the position error to the Friction Compensation Window. Within the window, the servo integrators are also disabled. Thus, once the position error reaches or exceeds the value of the Friction Compensation Window attribute, the full Friction Compensation value is applied. If the Friction Compensation Window is set to zero, this feature is effectively disabled.

A non-zero Friction Compensation Window has the effect of softening the Friction Compensation as its applied to the Servo Output and reducing the dithering effect that it can create. This generally allows higher values of Friction Compensation to be applied. Hunting is also eliminated at the cost of a small steady-state error.

Backlash Compensation

Reversal Offset

Backlash Reversal Offset provides the capability to compensate for positional inaccuracy introduced by mechanical backlash. For example, power-train type applications require a high level of accuracy and repeatability during machining operations. Axis motion is often generated by a number of mechanical components, a motor, a gearbox, and a ball-screw that may introduce inaccuracies and that are subject to wear over their lifetime. Therefore, when an axis is commanded to reverse direction, mechanical play in the machine (through the gearing, ball-screw, etc.) may result in a small amount of motor motion without axis motion. As a result, the feedback device

may indicate movement even though the axis has not physically moved.

If a value of zero is applied to the Backlash Reversal Offset, the feature is effectively disabled. Once enabled by a non-zero value, and the load is engaged by a reversal of the commanded motion, changing the Backlash Reversal Offset can cause the axis to shift as the offset correction is applied to the command position.

Stabilization Window

The Backlash Stabilization Window controls the Backlash Stabilization feature in the servo control loop.

Properly configured with a suitable value for the Backlash Stabilization Window, entirely eliminates the gearbox buzz without sacrificing any servo performance. In general, this value should be set to the measured backlash distance. A Backlash Stabilization Window value of zero effectively disables the feature.

Velocity Offset

Provides a dynamic velocity correction to the output of the position servo loop, in position units per second.

Torque/Force Offset

Provides a dynamic torque command correction to the output of the velocity servo loop, as a percentage of velocity servo loop output.

Manual Adjust

Click on this button to open the Offset tab of the Manual Adjust dialog for online editing of the Friction/Deadband Compensation, Backlash

Compensation, Velocity Offset, Torque Offset, and Output Offset parameters.

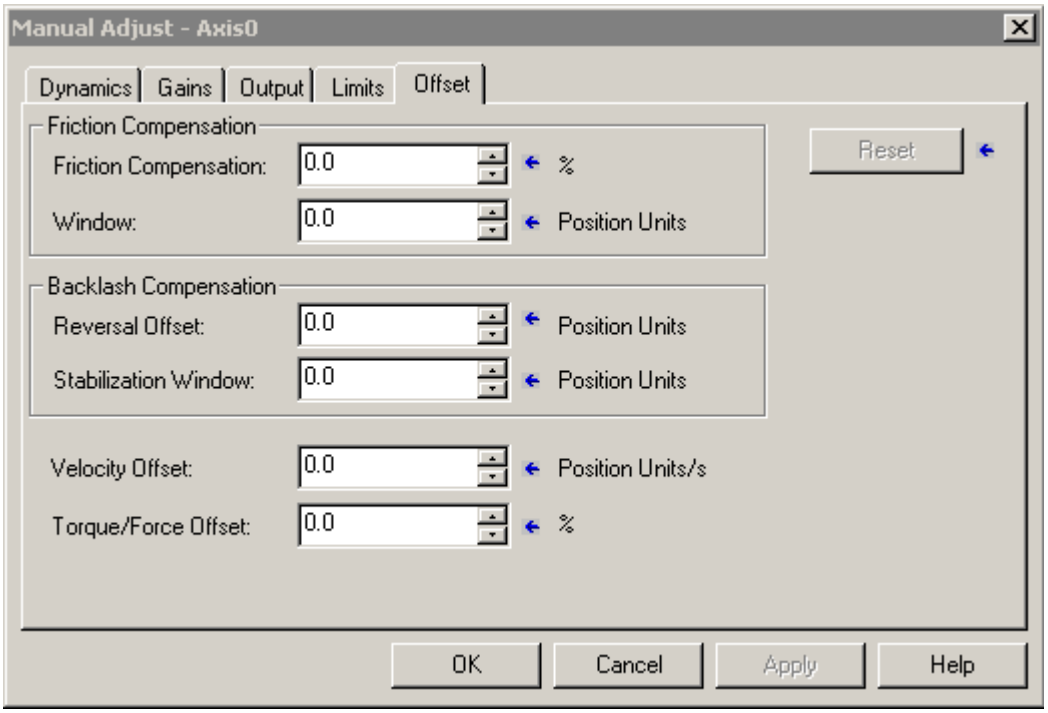


Figure 6.49 Axis Properties - Offset Tab Manual Adjust Screen for Axis_Servo_Drive

Note: The Manual Adjust button is disabled when RSLogix 5000 is in Wizard mode, and when offline edits to the above parameters have not yet been saved or applied.

Fault Actions Tab - AXIS_SERVO

Use this tab to specify the actions that are taken in response to the following faults:

- Drive Fault
- Feedback Noise Fault
- Feedback Loss Fault
- Position Error Fault
- Soft Overtravel Fault

for an axis of the type AXIS_SERVO.

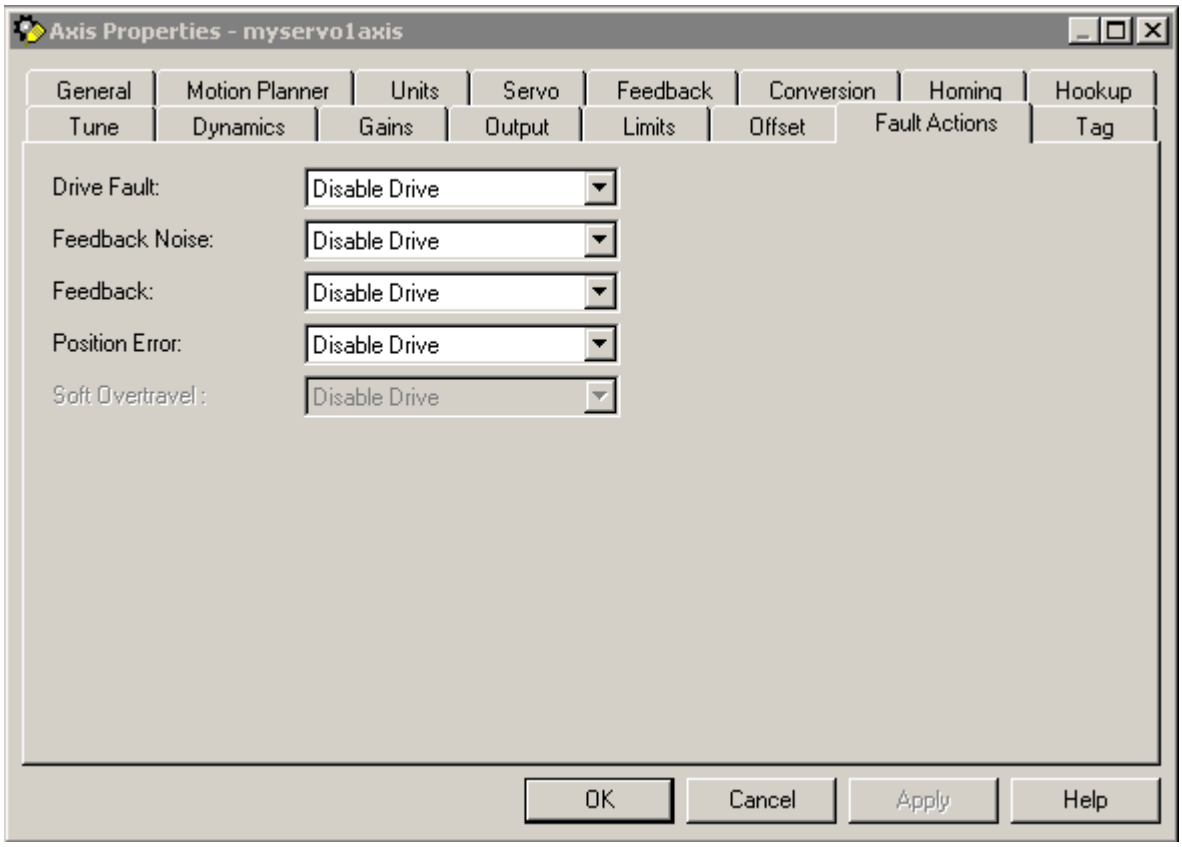


Figure 6.50 Axis Properties - Fault Actions Tab for Axis_Servo

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Select one of the following fault actions for each fault type:

- Shutdown - If a fault action is set to Shutdown, then when the associated fault occurs, axis servo action is immediately disabled, the servo amplifier output is zeroed, and the appropriate drive enable output is deactivated. Shutdown is the most severe action to a fault and it is usually reserved for faults that could endanger the machine or the operator if power is not removed as quickly and completely as possible.

- Disable Drive - If a fault action is set to Disable Drive, then when the associated fault occurs, axis servo action is immediately disabled, the servo amplifier output is zeroed, and the appropriate drive enable output is deactivated.

- Stop Motion - If a fault action is set to Stop Motion, then when the associated fault occurs, the axis immediately starts decelerating the axis command position to a stop at the configured Maximum Deceleration Rate without disabling servo action or the servo modules Drive Enable output. This is the gentlest stopping mechanism in response to a fault. It is usually used for less severe faults. After the stop command fault action has stopped the axis, no further motion can be generated until the fault is first cleared.

- Status Only - If a fault action is set to Status Only, then when the associated fault occurs, no action is taken. The application program must handle any motion faults. In general, this setting should only be used in applications where the standard fault actions are not appropriate.

ATTENTION

Selecting the wrong fault action for your application can cause a dangerous condition resulting in unexpected motion, damage to the equipment, and physical injury or death. Keep clear of moving machinery.

Drive Fault

Specifies the fault action to be taken when a drive fault condition is detected, for an axis with the Drive Fault Input enabled (in the Servo tab of this dialog) that is configured as Servo (in the General tab of this dialog). The available actions for this fault are Shutdown and Disable Drive.

Feedback Noise

Specifies the fault action to be taken when excessive feedback noise is detected. The available actions for this fault are Shutdown, Disable Drive, Stop Motion and Status Only.

Feedback Loss

Specifies the fault action to be taken when feedback loss condition is detected. The available actions for this fault are Shutdown, Disable Drive, Stop Motion and Status Only.

Position Error

Specifies the fault action to be taken when position error exceeds the position tolerance set for the axis, for an axis configured as Servo (in the General tab of this dialog). The available actions for this fault are Shutdown, Disable Drive, Stop Motion and Status Only.

Soft Overtravel

Specifies the fault action to be taken when a software overtravel error occurs, for an axis with Soft Travel Limits enabled and configured (in the Limits tab of this dialog) that is configured as Servo (in the General tab of this dialog). The available actions for this fault are Shutdown, Disable Drive, Stop Motion and Status Only.

Fault Actions Tab - AXIS_SERVO_DRIVE

Use this tab to specify the actions that are taken in response to the following faults:

- Drive Thermal Fault
- Motor Thermal Fault
- Feedback Noise Fault
- Feedback Fault
- Position Error Fault
- Hard Overtravel Fault
- Soft Overtravel Fault

for an axis of the type AXIS_SERVO_DRIVE.

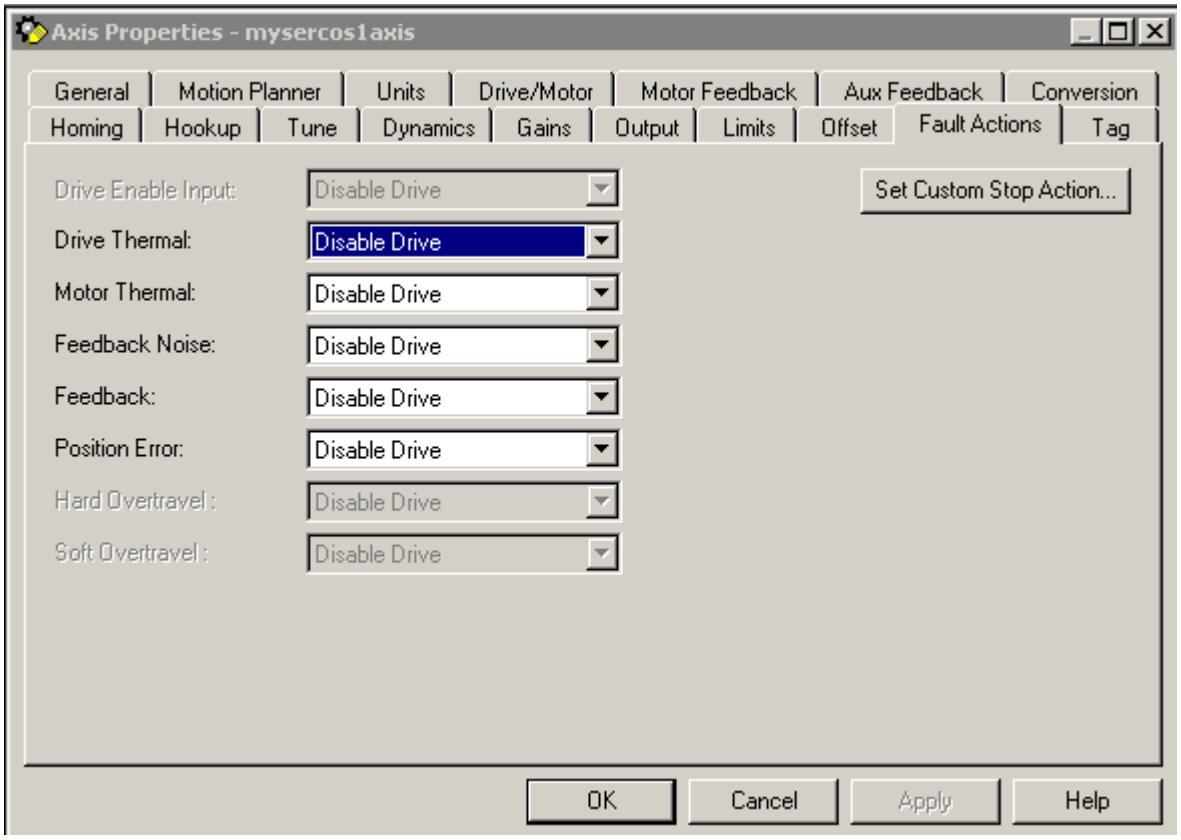


Figure 6.51 Axis Properties - Fault Action Tab for Axis_Servo_Drive

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Select one of the following fault actions for each fault type:

- Shutdown - If a fault action is set to Shutdown, then when the associated fault occurs, axis servo action is immediately disabled, the servo amplifier output is zeroed, and the appropriate drive enable output is deactivated. Shutdown is the most severe action to a fault and it is usually reserved for faults that could endanger the machine or the operator if power is not removed as quickly and completely as possible.

- Disable Drive - If a fault action is set to Disable Drive, then when the associated fault occurs, it brings the axis to a stop by applying the Stopping Torque for up to the Stopping Time Limit. During this period the servo is active but no longer tracking the command reference from logix. Once the axis is stopped (or the stopping limit is exceeded) the servo and power structure are disabled.

- Stop Motion - If a fault action is set to Stop Motion, then when the associated fault occurs, the axis immediately starts decelerating the axis command position to a stop at the configured Maximum Deceleration Rate without disabling servo action or the servo modules Drive Enable output. This is the gentlest stopping mechanism in response to a fault. It is usually used for less severe faults. After the stop command fault action has stopped the axis, no further motion can be generated until the fault is first cleared.

- Status Only - If a fault action is set to Status Only, then when the associated fault occurs, no action is taken. The application program must handle any motion faults. In general, this setting should only be used in applications where the standard fault actions are not appropriate.

ATTENTION

Selecting the wrong fault action for your application can cause a dangerous condition. Keep clear of moving machinery.

Drive Thermal

Specifies the fault action to be taken when a Drive Thermal Fault is detected, for an axis configured as Servo (in the General tab of this dialog). The available actions for this fault are Shutdown, Disable Drive, Stop Motion, and Status Only.

Motor Thermal

Specifies the fault action to be taken when a Motor Thermal Fault is detected, for an axis configured as Servo (in the General tab of this dialog). The available actions for this fault are Shutdown, Disable Drive, Stop Motion, and Status Only.

Feedback Noise

Specifies the fault action to be taken when excessive feedback noise is detected. The available actions for this fault are Shutdown, Disable Drive, Stop Motion, and Status Only.

Feedback

Specifies the fault action to be taken when Feedback Fault is detected. The available actions for this fault are Shutdown, Disable Drive, Stop Motion, and Status Only.

Position Error

Specifies the fault action to be taken when position error exceeds the position tolerance set for the axis, for an axis configured as Servo (in the General tab of this dialog). The available actions for this fault are Shutdown, Disable Drive, Stop Motion and Status Only.

Hard Overtravel

Specifies the fault action to be taken when an axis encounters a travel limit switch, for an axis configured as Servo (in the General tab of this dialog). The available actions for this fault are Shutdown, Disable Drive, Stop Motion, and Status Only.

Soft Overtravel

Specifies the fault action to be taken when a software overtravel error occurs, for an axis with Soft Travel Limits enabled and configured (in the Limits tab of this dialog) that is configured as Servo (in the General tab of this dialog). The available actions for this fault are Shutdown, Disable Drive, Stop Motion and Status Only.

Set Custom Stop Action

Opens the Custom Stop Action Attributes dialog.

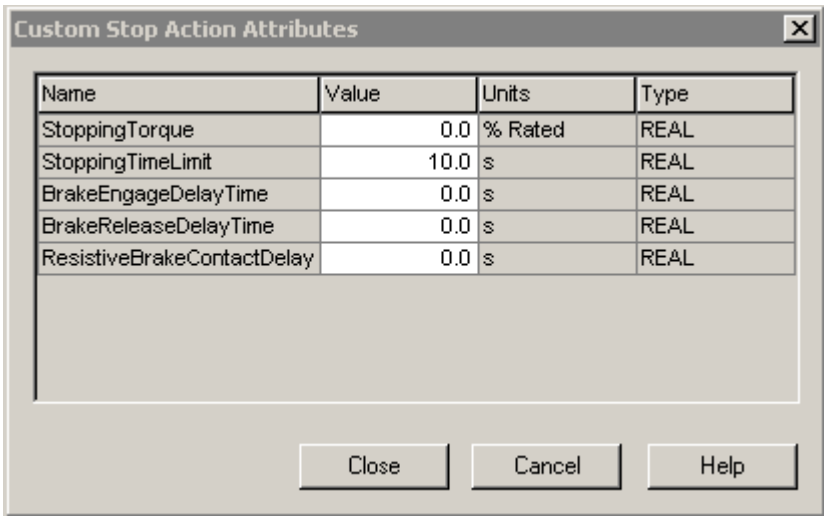


Figure 6.52 Set Custom Stop Action Dialog From Fault Actions Tab for the AXIS_SERVO_DRIVE

Use this dialog to monitor and edit the Stop Action-related attributes.

When a parameter transitions to a read-only state, any pending changes to parameter values are lost, and the parameter reverts to the most recently saved parameter value.

When multiple workstations connect to the same controller using RSLogix 5000 and invoke the Axis Wizard or Axis Properties dialog, the firmware allows only the first workstation to make any changes to axis attributes. The second workstation switches to a Read Only mode, indicated in the title bar, so that you may view the changes from that workstation, but not edit them.

Attributes

The following attribute, or parameter, values can be monitored and edited in this dialog box.

Attribute	Description
StoppingTorque	This attribute displays the amount of torque available to stop the motor. This attribute has a value range of 0 to 1000.
StoppingTimeLimit	This attribute displays the maximum amount of time that the drive amplifier remains enabled while trying to stop. It is useful for very slow velocity rate change settings. This attribute has a value range of 0 to 6553.5.
BrakeEngageDelayTime	When servo axis is disabled and the drive decelerates to a minimum speed, the drive maintains torque until this time has elapsed. This time allows the motor's brake to be set. This attribute has a value range of 0 to 6.5535.
BrakeReleaseDelayTime	When the servo axis is enabled , the drive activates the torque to the motor but ignores the command values from the Logix controller until this time has elapsed. This time allows the motor's brake to release. This attribute has a value of 0 to 6.5535.
ResistiveBrakeContactDelay	The Resistive Brake Contact Delay attribute is used to control an optional external Resistive Brake Module (RBM). The RBM sits between the drive and the motor and uses an internal contactor to switch the motor between the drive and a resisted load.

Tag Tab Use this tab to modify the name and description of the axis. When you are online, all of the parameters on this tab transition to a

read-only state, and cannot be modified. If you go online before you save your changes, all pending changes revert to their previously-saved state.

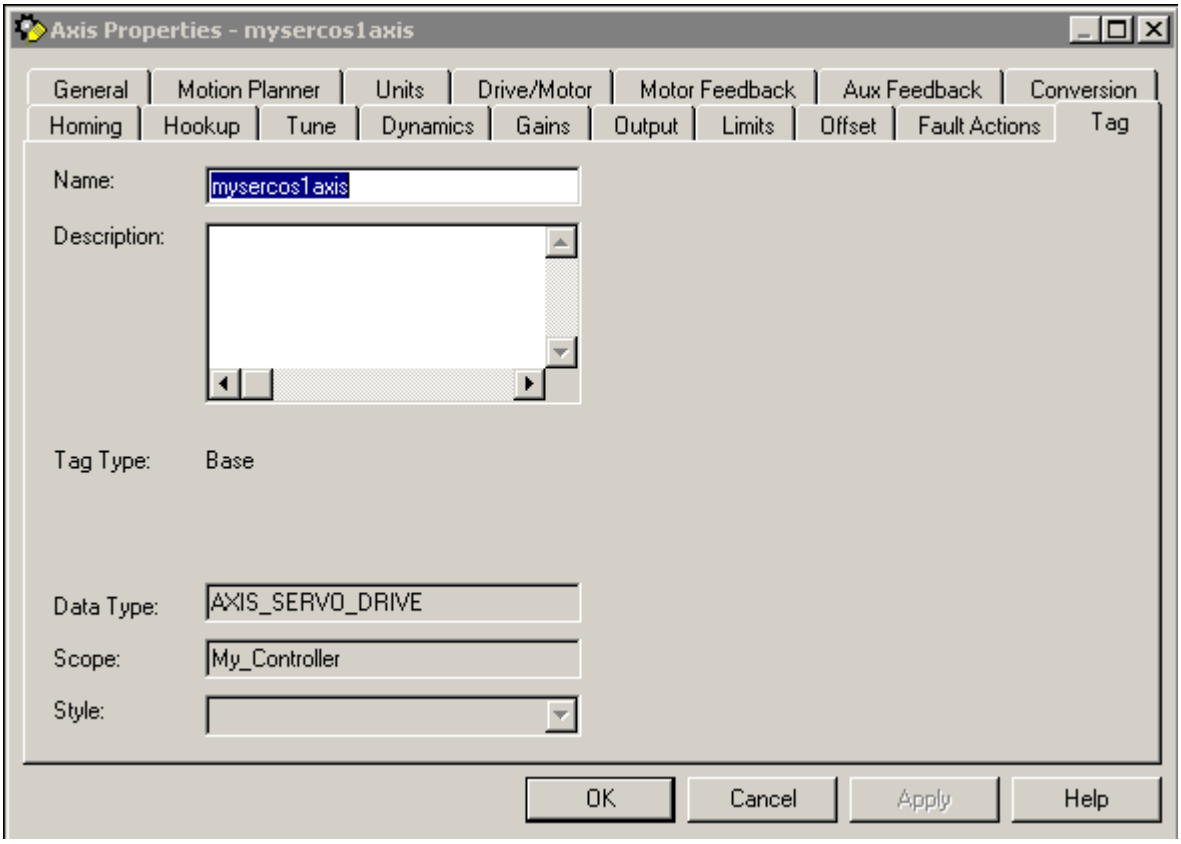


Figure 6.53 Axis Properties - Tag Tab

Name

Displays the name of the current tag. You can rename this tag, if you wish.

Description

Displays the description of the current tag, if any is available. You can edit this description, if you wish.

Tag Type

Indicates the type of the current tag. This type may be:

- Base
- Alias
- Consumed

Displays the data type associated with the current tag.

Data Type

Displays the axis data type of the current tag.

Scope

Displays the scope of the current tag. The scope is either controller scope, or program scope, based on one of the existing programs in the controller.

Style

Displays the default style in which to display the value of the tag. Note that style is only applicable to an atomic tag; a structure tag does not have a display style.

Assigning Additional Motion Axes

You can assign additional axes by repeating the preceding sections. To name and assign another axis, refer to the *Naming an Axis* section.

You can assign up to 32 axes to a Logix5550, 5555, or 5563 controller.

Creating & Configuring Your Coordinate System Tag

Introduction

The Coordinate System tag is used to set the attribute values to be used by the Multi-Axis Coordinated Motion instructions in your motion applications. The Coordinate System tag must exist before you can run any of the Multi-Axis Coordinated Motion instructions. This is where you introduce the COORDINATE_SYSTEM data type, associate the Coordinate System to a Motion Group, associate the axes to the Coordinate System, set the dimension, and define the values later used by the operands of the Multi-Axis Motion Instructions. The values for Coordination Units, Maximum Speed, Maximum Acceleration, Maximum Deceleration, Actual Position Tolerance, and Command Position Tolerance are all defined by the information included when the Coordinate System tag is configured. This chapter describes how to name, configure, and edit your Coordinate System tag.

Creating a Coordinate System

Creating a coordinate system adds it to your application. There are four ways in which you can initiate the creation of a coordinate system. The first way is to go to the **File** pull-down menu, select **New Component**, and then select **Tag**.

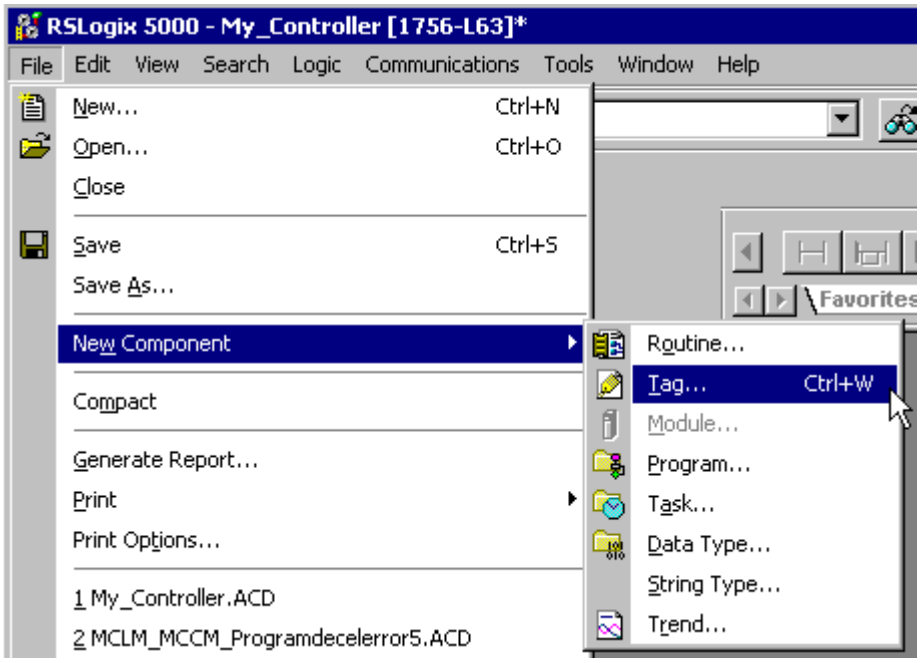


Figure 7.1 File Menu to New Component to Tag

The second way is to go the Controller organizer and right click on Controller Tags and select New Tag from the pop-up menu.

Figure 7.2 Accessing the New Tag Menu From The Controller Tag

The third way also employs the right mouse click method. Right click on the Motion Group in the Controller Organizer and select New Coordinate System from the menu.

Figure 7.3 Creating a New Coordinate System From Motion Group

The final way to create a new coordinate system tag is by right clicking on Ungrouped Axes and selecting New Coordinate System from the menu.

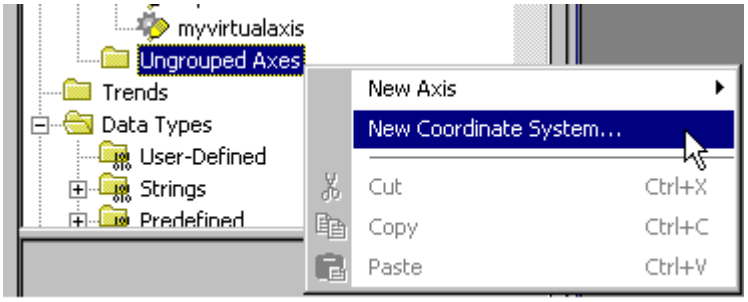


Figure 7.4 Creating a Coordinate System From Ungrouped Axes

Regardless of the method you use the New Tag window appears.

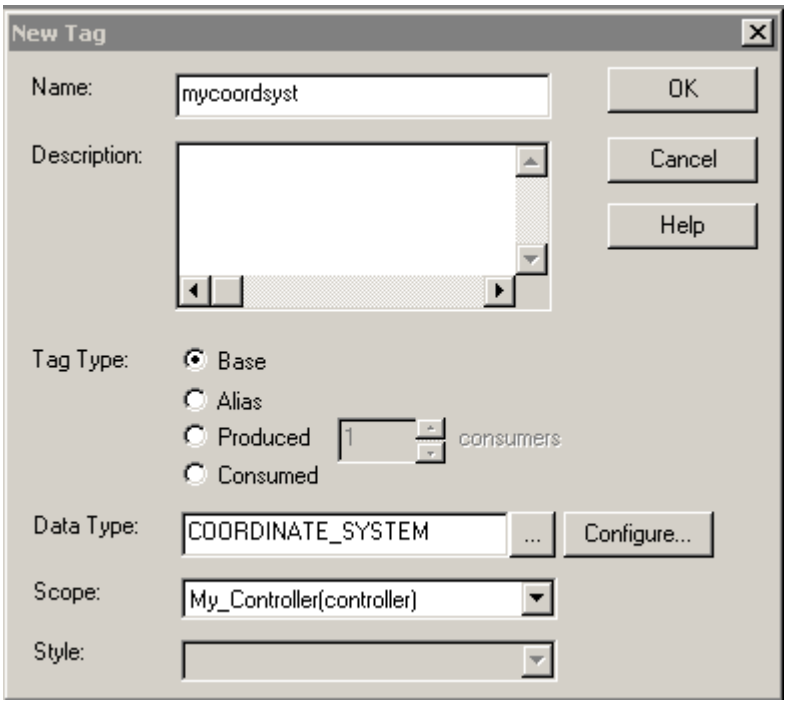


Figure 7.5 New Tag Dialog

The method used to access the New Tag Dialog determines how much of the dialog is already filled in when the window displays. If you accessed the New Tag window from either Motion Group or Ungrouped Axes, the Data Type fills in automatically.

Entering Tag Information

A tag allows you to allocate and reference data stored in the controller. A tag can be a single element, array, or a structure. With COORDINATE_SYSTEM selected as the Data Type, there are only two types of tags that you can create:

- A base tag allows you to create your own internal data storage.
- An alias tag allows you to assign your own name to an existing coordinate system tag.

Use this dialog to create new tags.

You can create base tags and alias tags while the controller is either online or offline, as long as the new tag is verified. However, tags created online can only be created in the Ungrouped Axes folder and cannot be used for motion at that time.

New Tag Parameters

The following parameters appear on the New Tag dialog when you are creating a base tag or an alias tag.

Make entries in the following fields.

Field	Entry
Name	Type a name for the coordinate system tag. The name can have a maximum of 40 characters containing letters, numbers and underscores (_).
Description	Type a description for your motion axis for annotation purposes. This field is optional.
Tag Type	Click on the radio button for the type of tag to create. The only legal choices are Tag and Alias. Selecting either Produced or Consumed generates an error when the OK button is pressed.
Alias For	This field only displays when Alias is selected for Tag Type. Enter the name of the related Base Tag.
Data type	Enter COORDINATE_SYSTEM.
Scope	A Coordinate System tag can only be created at the controller scope.

Name

Enter a relevant name for the new tag. The name can be up to 40 characters and can be composed of letters, numbers, or underscores (_).

Description

Enter a description of the tag. This is an optional field and is used for annotating the tag.

Tag Type

For a Coordinate System you may choose either Base or Alias for the Tag Type. Click on the appropriate radio button for the type of tag you are creating.

- Base – refers to a normal tag (selected by default)

- Alias – refers to a tag, which references another tag with the same definition. Special parameters appear on the New Tag dialog that allow you to identify to which base tag the alias refers.

Alias For:

If you selected Alias as the Tag Type the **Alias For:** field displays. Enter the name of the associated Base Tag.

Data Type

In the Data Type field select COORDINATE_SYSTEM if you entered from either method that did not fill this field automatically.

Scope

Enter the Scope for the tag. A Coordinated System Tag can only be Controller Scope.

Style

The Style parameter is not activated. No entry for this field is possible.

After the information for the tag is entered, you have two options. You can either press the OK button to create the tag or you can press the Configure Button located next to the Data Type field to use the Wizard screens to enter the values for the Coordinate System Tag.

Pressing the OK button, creates the tag and automatically places it in the Ungrouped Axes folder or the Motion Group if the tag was initiated from the Motion Group menu.

Pressing the Configure button next to the Data Type field invokes the Coordinate System Tag Wizard to let you continue to configure the Coordinate System tag.

Coordinate System Wizard Screens

The Coordinate System Wizard screens walk you through the process of configuring a Coordinate System. These are the same screens that appear when you access Coordinate System Properties but instead of appearing as tabbed screens they advance you through the process by individual screens. At the bottom of each screen are a series of buttons. To advance to the next screen click on the Next button and the information you entered is saved and you advance to the next wizard screen. To end your progression through the Wizard screens click on the Finish button. The information entered to this point is saved and the Coordinate System is stored in the Controller Organizer

under either the Ungrouped Axes folder or the Motion Group (if a motion group has been associated with the coordinate system).

It is not necessary to use the Wizard screens to configure your Coordinate System. Once it has been created, you can access the Coordinate System Properties screen and enter the information for the Coordinate System. See the section entitled “Editing Coordinate System Properties” later in this manual for detailed information about entering configuration information.

General Wizard Screen

The General screen lets you associate the tag to a Motion Group, enter the Coordinate System Type, select the Dimension for the tag (i.e. the number of associated axes), enter the associated axis information, and select whether or not to update Actual Position values of the Coordinate System automatically during operation. This screen has the same fields as the General Tab found under Coordinate System Properties.

Units Wizard Screen

The Units screen is where you determine the units that define the coordinate system. At this screen you define the Coordination Units and the Conversion Ratios. This screen has the same fields as the Units Tab found under Coordinate System Properties.

Dynamics Wizard Screen

The Dynamics screen is for entering the Vector values used for Maximum Speed, Maximum Acceleration, and Maximum Deceleration. It is also used for entering the Actual and Command Position Tolerance values. This screen has the same fields as the Dynamics Tab found under Coordinate System Properties.

Manual Adjust Button

The Manual Adjust button is inactive when creating a Coordinate System tag via the Wizard screens. It is active on the Dynamics Tab of the Coordinate System Properties screen. It is described in detail in the “Editing Coordinate System Properties” later in this chapter.

Tag Wizard Screen

The Tag screen lets you rename your Tag, edit your description and review the Tag Type, Data Type and Scope information.

The only fields that are editable on the Tag screen are the Name and Description fields. These are the same fields as on the New Tag screen and the Coordinate System Properties Tag Tab.

Editing Coordinate System Properties

Once you have created your Coordinate System in the New Tag window, you must then configure it. If you did not use the Wizard screens available from the Configure button on the New Tag screen, you can make your configuration selections from the Coordinate System Properties screen. You can also use the Coordinate System Properties screens to edit an existing Coordinate System tag. These have a series of Tabs that access a specific dialog for configuring the different facets of the Coordinate System. Make the appropriate entries for each of the fields. An asterisk appears on the Tab to indicate changes have been made but not implemented. Press the Apply button at the bottom of each dialog to save your selections.

TIP When you configure your Coordinate System, some fields may be unavailable (greyed-out) because of choices you made in the New Tag window.

In the Controller Organizer, right click on the coordinate system to edit and select Coordinate System Properties from the drop down menu.

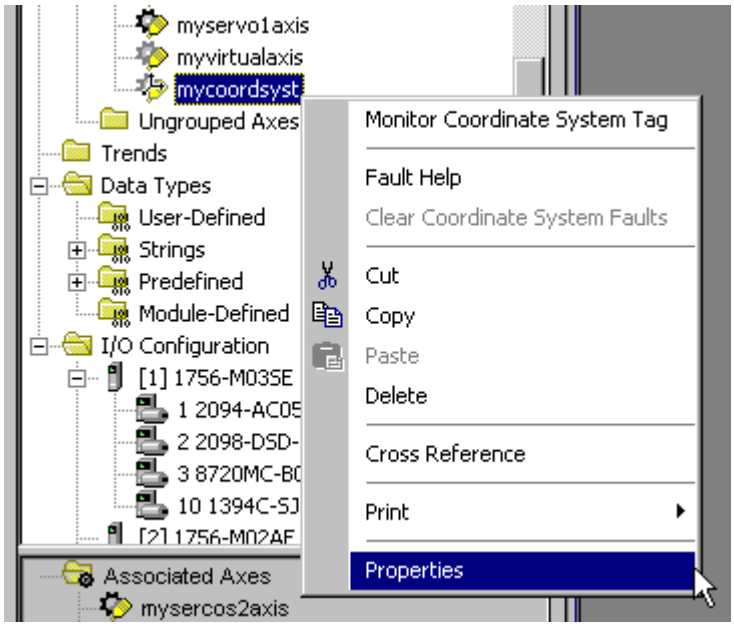


Figure 7.6 Select Properties after right clicking on Coordinate System

The Coordinate System Properties General window appears. The name of the Coordinate System tag that is being edited appears in the

title bar to the right of Coordinate System Properties. The General screen is shown below.

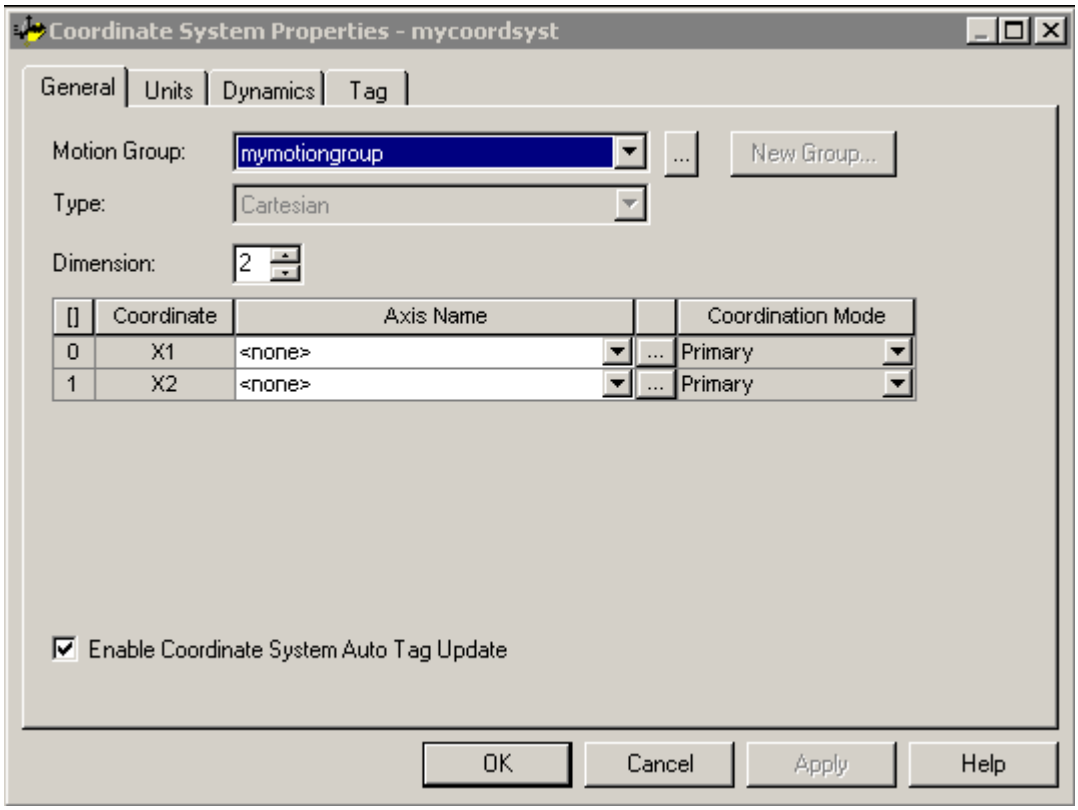


Figure 7.7 Coordinate System Properties - General Tab

General Tab

Use this tab to do the following for a coordinate system:

- Assign the coordinate system, or terminate the assignment of a coordinate system, to a Motion Group.
- Change the number of dimension i.e. the number of axes.
- Assign axes to the coordinate system tag.
- Enable/Disable automatic updating of the tag.

Note: RSLogix 5000 supports only one Motion Group tag per controller.

Motion Group

Selects and displays the Motion Group to which the Coordinate System is associated. A Coordinate System assigned to a Motion Group appears in the Motion Groups branch of the Controller Organizer, under the selected Motion Group sub-branch. Selecting <none> terminates the Motion Group association, and moves the coordinate

system to the Ungrouped Axes sub-branch of the Motions Groups branch.

Ellipsis (…) button

Opens the Motion Group Properties dialog box for the Assigned Motion Group, where you can edit the Motion Group properties. If no Motion Group is assigned to this coordinate system, this button is disabled (grayed out).

New Group button

The New Group button opens the New Tag dialog box, where you can create a new Motion Group tag. This button is enabled only if no Motion Group tag has been created.

Type

This read-only field displays the type of coordinate system. It currently only supports a Cartesian system therefore the field automatically fills with Cartesian and it cannot be edited.

Dimension

Enter the dimension, i.e. the number of axes, that this coordinated system is to support. The options are 1, 2, or 3 in keeping with its support of a maximum of three axes. Changes in the Dimension spin box also reflect in the Axis Grid by either expanding or contracting the number of fields available. Data is set back to the defaults for any axis that is removed from the Axis Grid due to reducing the Dimension field.

Axis Grid

The Axis Grid is where you associate axes to the Coordinate System. There are five columns in the Axis Grid that provide information about the axes in relation to the Coordinate System.

[ ] (Brackets)

The Brackets column displays the indices in tag arrays used with the current coordinate system. The tag arrays used in multi-axis coordinated motion instructions map to axes using these indices.

Coordinate

The text in this column X1, X2, or X3 (depending on the entry to the Dimension field) is used as a cross reference to the axes in the grid. For a Cartesian system the mapping is simple.

Axis Name

The Axis Name column is a list of combo boxes (the number is determined by the Dimension field) used to assign axes to the coordinate system. The pulldown lists display all of the Base Tag axes defined in the project. (Alias Tag axes do not display in the pull down list.) They can be axes associated with the motion group, axes associated with other coordinated systems, or axes from the Ungrouped Axes folder. Select an axis from the pulldown list. The default is <none>. It is possible to assign fewer axes to the coordinate system than the Dimension field allows, however, you will receive a warning when you verify the coordinate system and if left in that state, the instruction generates a run-time error. You can only assign an axis once in a coordinate system. Ungrouped axes also generate a runtime error.

Ellipsis Button (...)

The Ellipsis buttons in this column take you to the Axis Properties pages for the axis listed in the row. See the “Creating and Configuring Your Motion Axis” chapter in this manual for information about the Axis Properties page.

Coordination Mode

The Coordination Mode column indicates the axes that are used in the velocity vector calculations. Only Primary axes are used in these calculations. Currently the only option is Primary. Therefore this column is automatically filled in as Primary and cannot be edited.

Enable Coordinate System Auto Tag Update

The Enable Coordinate System Auto Tag Update checkbox lets you determine whether or not the Actual Position values of the current coordinated system are automatically updated during operation. Click on the checkbox to enable this feature. The Coordinate System Auto Tag Update feature can ease your programming burden if you would need to add GSV statements to the program in order to get the desired result. However, by enabling this feature the Coarse Update rate is increased. Whether to use the Coordinate System Auto Tag Update feature depends upon the trade-offs between ease in programming

and increase in execution time. Some users may want to enable this feature in the initial programming of their system to work out the kinks and then disable it and enter the GSV statements to their program to lower their execution time.

> **Note:** Enabling this feature may result in some performance penalty.

Press **Apply** to implement your entries or cancel to not save the new entries.

To edit the Units properties, select the Units tab to access the Coordinate System Properties Units dialog.

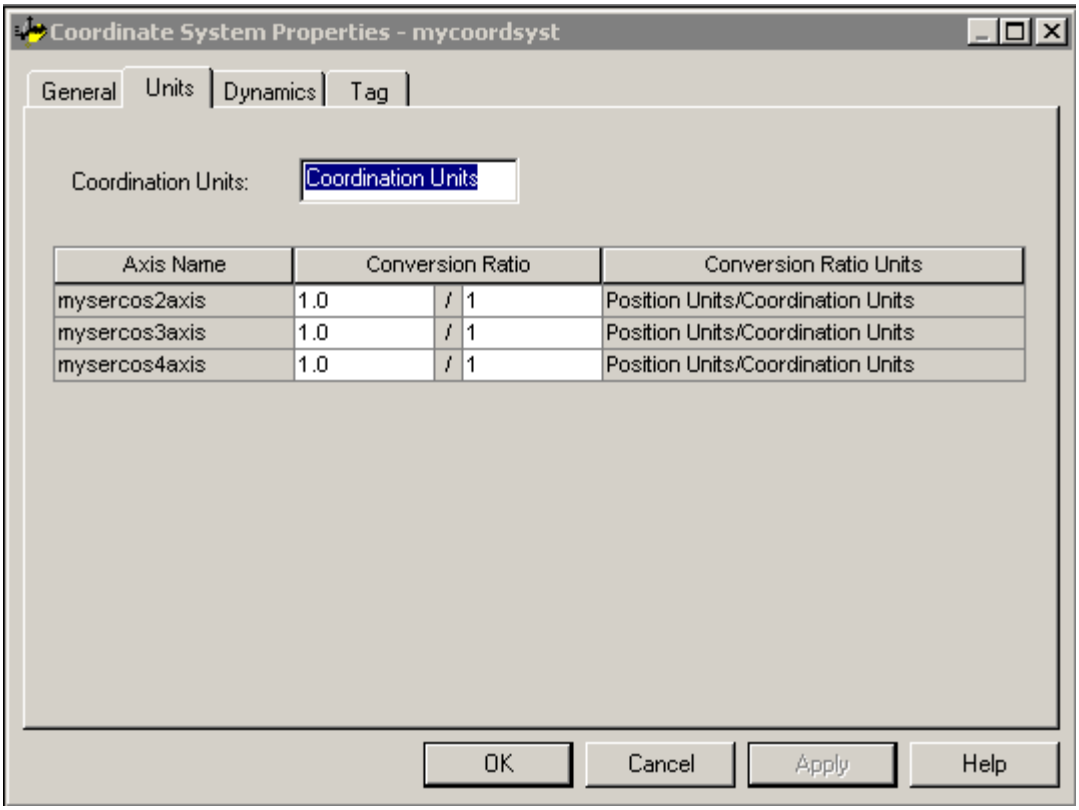


Figure 7.8 Coordinate System Properties - Units Tab

Units Tab

The Units Tab of the Coordinate System Properties is where you determine the units that define the coordinate system. This screen is where you define the Coordination Units and the Conversion Ratios.

Coordination Units

The Coordination Units field lets you define the units to be used for measuring and calculating motion related values such as position, velocity, and the like. The coordination units do not need to be the

same for each coordinate system. Enter units that are relevant to your application and maximize ease of use. When you change the Coordination Units, the second portion of the Coordination Ratio Units automatically changes to reflect the new units. Coordination Units is the default.

Axis Grid

The Axis Grid of the Units page displays the axis names associated with the Coordinate System, the conversion ratio, and the units used to measure the conversion ratio.

Axis Name

The Axis Name column contains the names of the axes assigned to the Coordinate System in the General screen. These names appear in the order that they were configured into the current coordinate system. This column is not editable from this screen.

Conversion Ratio

The Conversion Ratio column defines the relationship of axis position units to coordination units for each axis. For example: If the position units for an axis is in millimeters and the axis is associated with a coordinate system whose units are in inches, then the conversion ratio for this axis/coordinate system association is 25.4/1 and can be specified in the appropriate row of the Axis Grid.

Note: The numerator can be entered as a float or an integer. The denominator must be entered as an integer only.

Conversion Ratio Units

The Conversion Ratio Units column displays the axis position units to coordination units used. The Axis Position units are defined in the Axis Properties – Units screen and the coordination units are defined in Coordinated System Properties – Units screen. These values are dynamically updated when changes are made to either axis position units or coordination units.

Click on the Apply button to preserve your edits or Cancel to discard your changes.

Click on the Dynamics Tab to access the Coordinate System Properties Dynamics dialog.

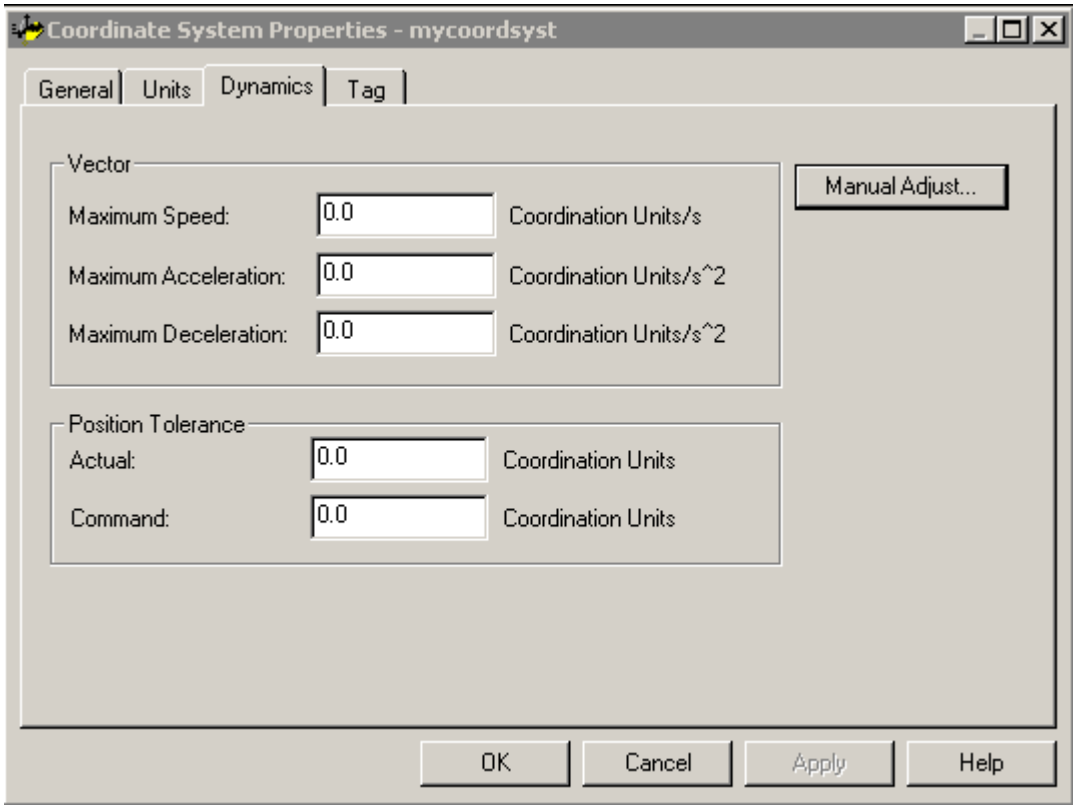


Figure 7.9 Coordinate System Properties - Dynamics Tab

Dynamics Tab

The Dynamics dialog of the Coordinate System is for entering the Vector values used for Maximum Speed, Maximum Acceleration, and Maximum Deceleration. It is also used for entering the Actual and Command Position Tolerance values.

Vector Box

In the Vector box, values are entered for Maximum Speed, Maximum Acceleration, and Maximum Deceleration and are used by the Coordinated Motion instructions in calculations when their operands are expressed as percent of Maximum. The Coordination Units to the right of the edit boxes automatically change when the coordination units are redefined at the Units screen.

Maximum Speed

Enter the value for Maximum Speed to be used by the Coordinated Motion instructions in calculating vector speed when speed is expressed as a percent of maximum.

Maximum Acceleration

Enter the value for Maximum Acceleration to be used by the Coordinated Motion instructions to determine the acceleration rate to apply to the coordinate system vector when acceleration is expressed as a percent of maximum.

Maximum Deceleration

Enter the value for Maximum Deceleration to be used by the Coordinated Motion instructions to determine the deceleration rate to apply to the coordinate system vector when deceleration is expressed as a percent of maximum. The Maximum Deceleration value must be a non zero value to achieve any motion using the coordinate system.

Position Tolerance Box

In the Position Tolerance Box, values are entered for Actual and Command Position Tolerance values. See the Logix5000 Motion Instruction Set Reference Manual (1756-RM007) for more information regarding the use of Actual and Command Position Tolerance.

Actual

Enter the value in coordination units, for Actual Position to be used by Coordinated Motion instructions when they have a Termination Type of Actual Tolerance.

Command

Enter the value in coordination units, for Command Position to be used by Coordinated Motion instructions when they have a Termination Type of Command Tolerance.

Manual Adjust Button

The Manual Adjust button on the Coordinate System Dynamics Tab accesses the Manual Adjust Properties dialog. The Manual Adjust button is enabled only when there are no pending edits on the properties dialog.

Dynamics Tab Manual Adjust

At this screen you can make changes to the Vector and Position Tolerance values. See the explanations for the Vector and Position

Tolerance fields in the explanation of the Dynamics Tab earlier in this chapter.

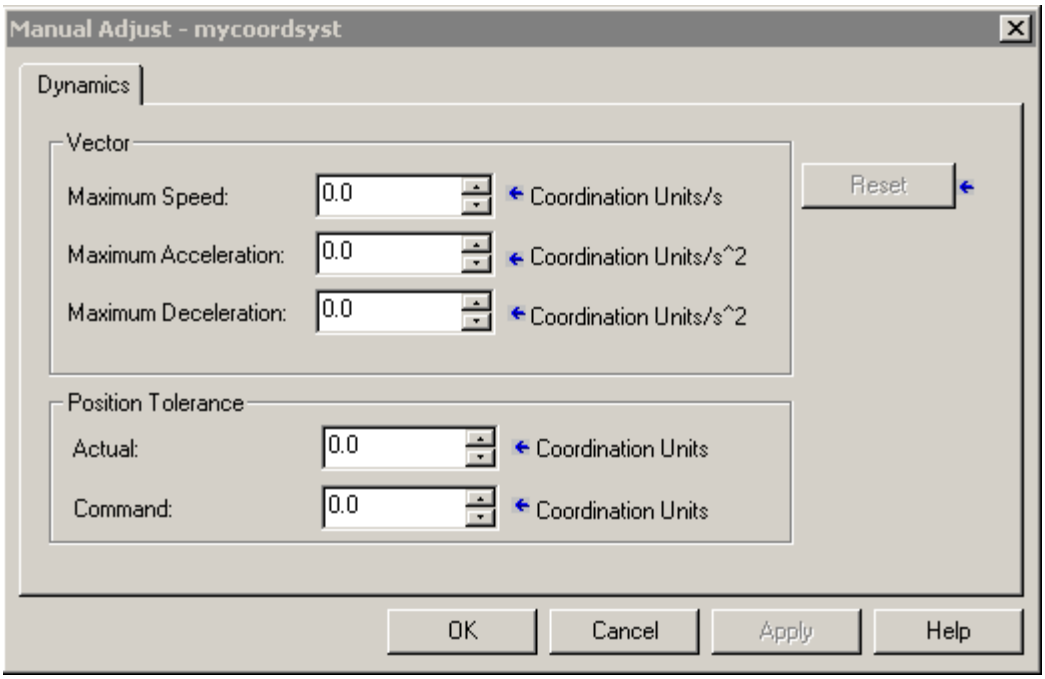


Figure 7.10 Coordinate System Properties - Manual Adjust Screen of Dynamics Tab

These changes can be made either on or off line. The blue arrows to the right of the fields indicate that they are immediate commit fields. This means that the values in those fields are immediately updated to the controller if on-line or to the project file if off line.

Reset Button

The Reset Button reloads the values that were present at the time this dialog was entered. The blue arrow to the right of the Reset button means that the values are immediately reset when the Reset button is clicked.

Tag Tab The Tag Tab is for reviewing your Tag information and renaming the tag or editing the description.

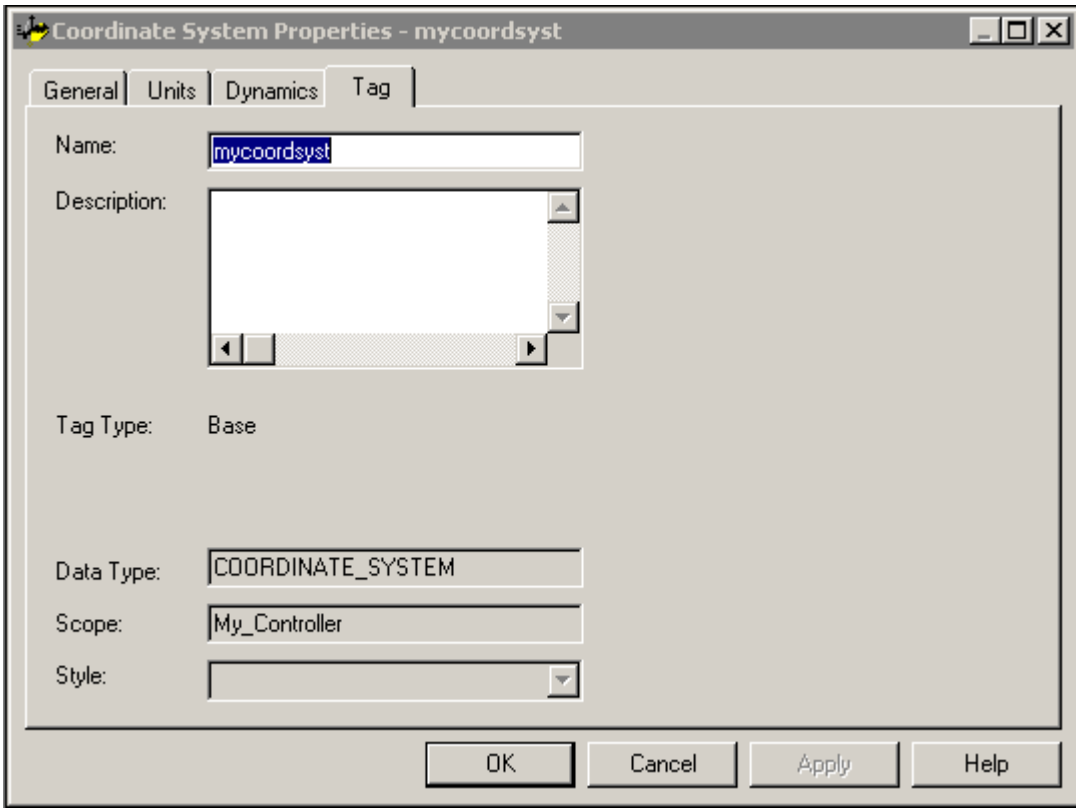


Figure 7.11 Coordinate System Properties - Tag Tab

Tag Tab Use this tab to modify the name and description of the coordinate system. When you are online, all of the parameters on this tab transition to a read-only state, and cannot be modified. If you go online before you save your changes, all pending changes revert to their previously-saved state.

Name

Displays the name of the current tag. You can rename the tag at this time. The name can be up to 40 characters and can include letters, numbers, and underscores (_). When you rename a tag, the new name replaces the old one in the Controller Organizer after click on the OK or Apply button.

Description

Displays the description of the current tag, if any is available. You can edit this description. The edited description replaces the existing description when you click on either the OK or Apply button.

Tag Type

Indicates the type of the current Coordinate System tag. This type may be:

- Base
- Alias

The field is not editable and is for informational purposes only.

Data Type

Displays the data type of the current Coordinate System tag which is always COORDINATE_SYSTEM. This field cannot be edited and is for informational purposes only.

Scope

Displays the scope of the current Coordinate System tag. The scope for a Coordinate System tag can only be controller scope. This field is not editable and is for informational purposes only.

Style

Not applicable.

Right Mouse Click Properties

Right mouse clicking on a specific Coordinate System launches the following pop-up menu.

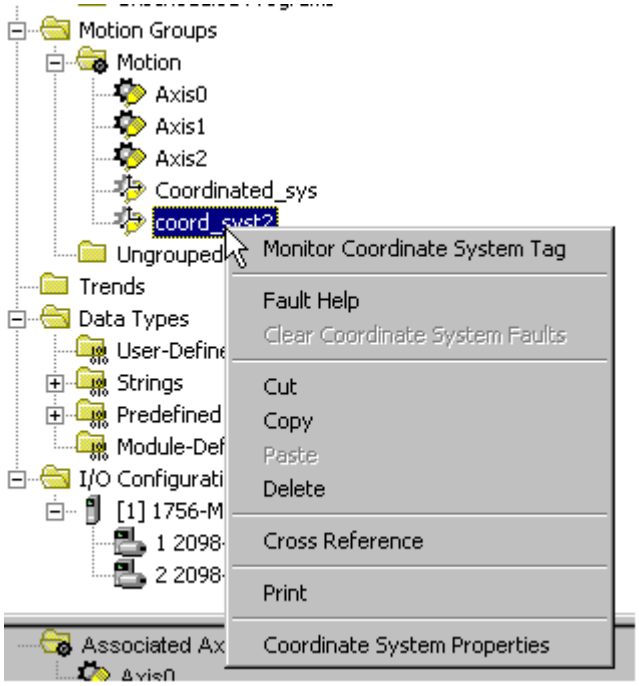


Figure 7.12 Right Click Pop-Up Menu

The menu has the following options:

- Monitor Coordinate System Tag – launches the data monitor with focus on the coordinate system tag from which the monitor was launched.
- Fault Help – launches on-line help to assist in understanding and correcting system faults.
- Clear Coordinate System Faults – clears all system faults associated with this coordinate system tag. This option is grayed out (inactive) if there are no faults associated with the selected coordinate system.
- Cut – cuts the coordinated system from its folder.
- Copy – copies the selected coordinated system and all of its properties.
- Paste – is never active from the right mouse click menu when initiated from the coordinate system tag. It only becomes active when initiated from a right mouse click on the Ungrouped Axes folder or Motion Group when a coordinate system has been Cut or Copied.
- Delete – removes the coordinate system from the Motion Group Tag or Ungrouped Axes folder.
- Cross Reference – launches the Cross Reference screen which lists all references associated with the selected coordinate system tag.

- Print – sends tag information to the printer.
- Coordinate System Properties – launches the tabbed Coordinate System Properties screen.

Cut, Copy, Paste, and Delete Behavior

A Coordinate System tag can be cut or copied from either a Motion Group Tag or the Ungrouped Axes folder. Once cut or copied it can be pasted into either a Motion Group Tag or the Ungrouped Folder.

Copy/Paste

A Copy/Paste operation implies creation of a new coordinate system tag. The new tag has the exact same properties as its host. It is automatically given a new name when pasted to its new location. The new name is the same as the old one but with a one added after the last existing character. For example: Copying and pasting the coordinate system tag coord_syst2 would create a new tag with the name coord_syst21. Subsequent copying and pasting of the same tag would increment the name by one on the last digit i.e. coord_syst22, coord_syst23, coord_syst24, etc. It can be pasted into the same motion group tag or into the Ungrouped Folder. A maximum of 32 Coordinate System tags can be created.

Cut/Paste

A Cut/Paste operation is used for moving the Coordinate System tag from either a Motion Group Tag to the Ungrouped Axes folder or vice versa. When a Cut/Paste operation is performed on a tag being moved from a Motion Group tag to the Ungrouped Axes folder it unassigns the coordinate system tag from the motion group. Likewise when it moves to the Motion Group tag it becomes assigned to the Motion group tag.

Delete

Delete removes the Coordinate System tag from a Motion Group Tag or the Ungrouped Axes folder. If a Motion Group is deleted, all coordinate system tags associated with that motion group are unassigned and placed in the Ungrouped Axes folder.

Configuring a 1394*x*-SJT*xx*-D Digital Servo Drive

To configure a 1394*x*-SJT*xx*-D drive module:

1. In the Controller Organizer, in the I/O Configuration branch, select a 1756-M08SE or 1756-M16SE motion module.

2. In the File menu, select New Component then Module.

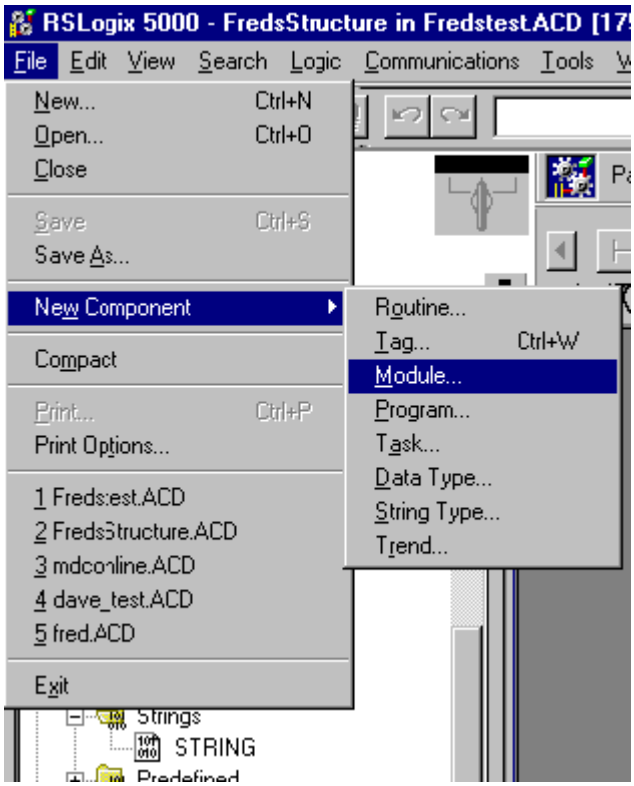


Figure 8.1 File Menu to New Component to Module

3. You can also right click on a selected 1756-MxxSE module and select New Module from the pop up menu.

4. In the Select Module Type dialog, select the desired 1394*x*-SJT*xx*-D drive module.

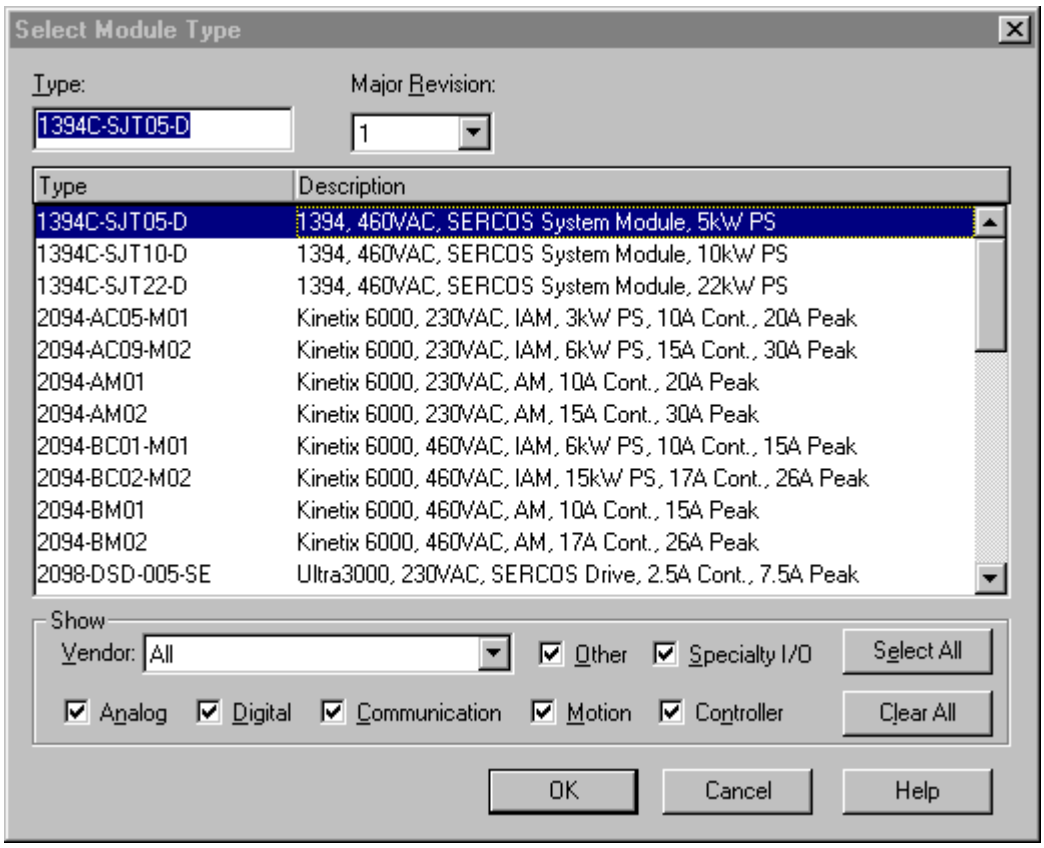


Figure 8.2 Select Module Type Screen

5. Press the OK button to close the Select Module Type dialog. The Module Properties wizard opens.

6. Fill in the required parameters for each page, then click the Next> button.

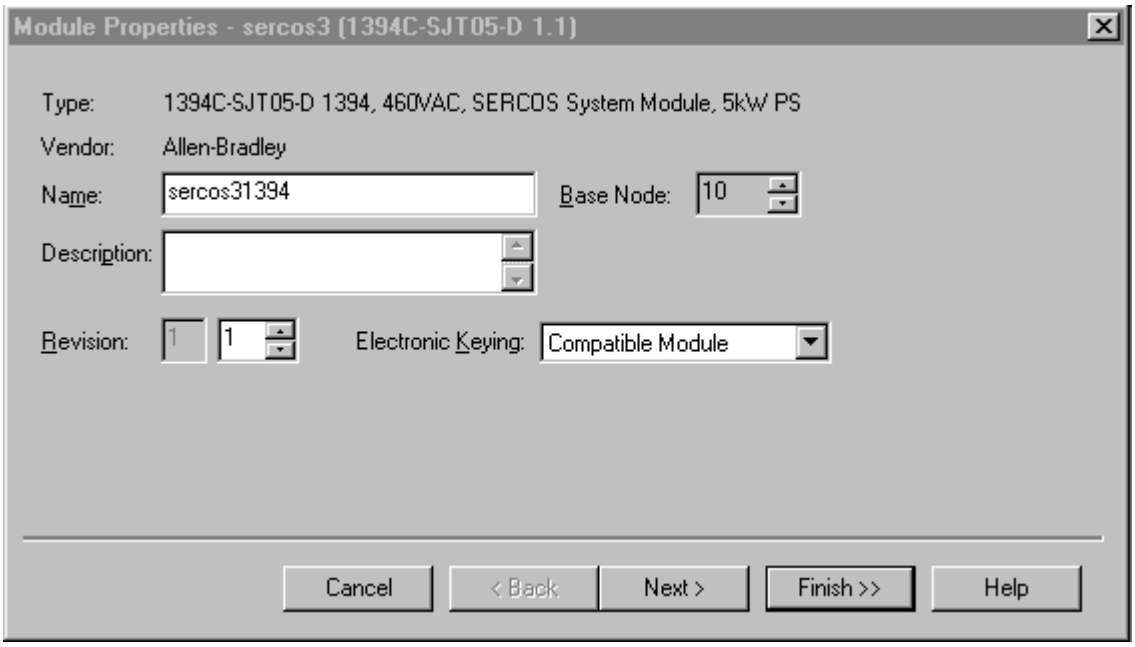


Figure 8.3 Module Properties Wizard Dialog - Naming the Drive

7. When you complete the last page, click the Finish> button. A new drive module displays beneath the selected 1756-M*xx*SE motion module.

1394*x*-SJT*xx*-D Digital Servo Drive Overview

The 1756-M*xx*SE 8 Axis SERCOS interface motion module can be connected to any of three drives:

- 1394*x*-SJT05-D 5 KW digital servo drive
- 1394*x*-SJT10-D 10 KW digital servo drive
- 1394*x*-SJT22-D 22 KW digital servo drive

Each drive can be associated with up to 4 axes of the AXIS_SERVO_DRIVE tag type. The 1756-M*xx*SE SERCOS interface module can support up to 32 axes.

The module for a 1394*x*-SJT*xx*-D drive has 5 tabs:

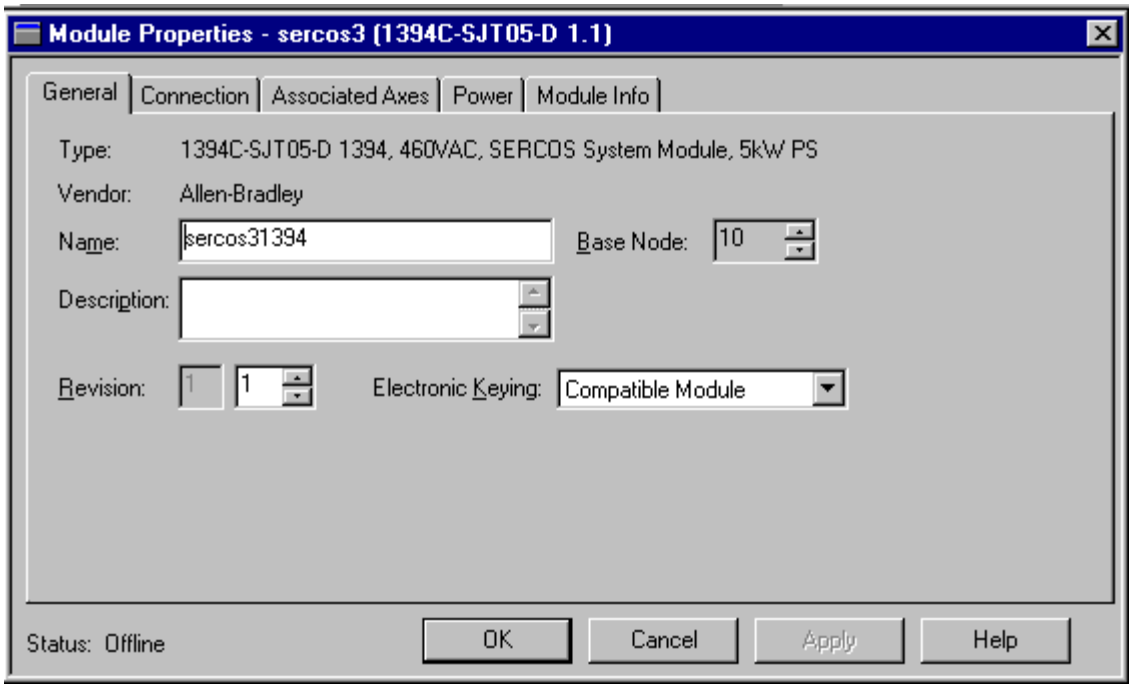


Figure 8.4 Module Properties - General Tab

- General tab
- Connection tab
- Axes Association
- Power tab
- Module Info tab.

General Tab

Use this tab to enter the module properties for 1394*x*-SJT*xx*-D digital servo drive modules.

IMPORTANT To create any one of the 1394*x*-SJT modules, the parent module must be a 1756-M*xx*SE 8 or 16 Axis SERCOS interface module.

On this tab, you can:

- view the type and description of the module being created
- view the vendor of the module being created
- enter the name of the module
- enter a description for the module
- set the Base Node for the module
- select the minor revision number of your module

- select Electronic Keying (Exact Match, Compatible Module, or Disable Keying)
- view the status the controller has about the module (you can only view the status while online)

Type

Displays the module type of the 1394*x*-SJT*xx*-D digital servo drive module being created (read only).

Vendor

Displays the vendor of the module being created (read only).

Name

Enter the name of the module. The name must be IEC 1131-3 compliant. If you attempt to enter an invalid character or exceed the maximum length, the software beeps and ignores the character.

Description

Enter a description for the module here, up to 128 characters. You can use any printable character in this field. If you exceed the maximum length, the software beeps to warn you, and ignores any extra characters.

Base Node

Type or select the Base Node number of the drive module. This node number is determined by multiplying the node number from the module's rotary switch (1 to 9) by a factor of ten. Thus, valid Base Node values are 10, 20, 30, 40, 50, 60, 70, 80 or 90.

Revision

Select the minor revision number of your module.

The revision is divided into the major revision and minor revision. The major revision displayed statically is chosen on the Select Module Type dialog.

The major revision is used to indicate the revision of the interface to the module. The minor revision is used to indicate the firmware revision.

Electronic Keying

Select one of these keying options for your module during initial module configuration:

- Exact Match - all of the parameters described below must match or the inserted module rejects the connection.
  - Vendor
  - Product Type
  - Catalog Number
  - Major Revision
  - Minor Revision
- Compatible Module
  - the Module Types, Catalog Number, and Major Revision must match
  - the Minor Revision of the physical module must be equal to or greater than the one specified in the software

  or the inserted module rejects the connection
- Disable Keying – Controller does not employ keying at all.

ATTENTION

Changing the Electronic Keying selection may cause the connection to the module to be broken and may result in a loss of data.

Be extremely cautious when using this option; if used incorrectly, this option can lead to personal injury or death, property damage or economic loss.

When you insert a module into a slot in a ControlLogix chassis, RSLogix 5000 compares the following information for the inserted module to that of the configured slot:

- Vendor
- Product Type
- Catalog Number
- Major Revision
- Minor Revision

This feature prevents the inadvertent insertion of the wrong module in the wrong slot.

Connection Tab Use this tab to define controller to drive module behavior.

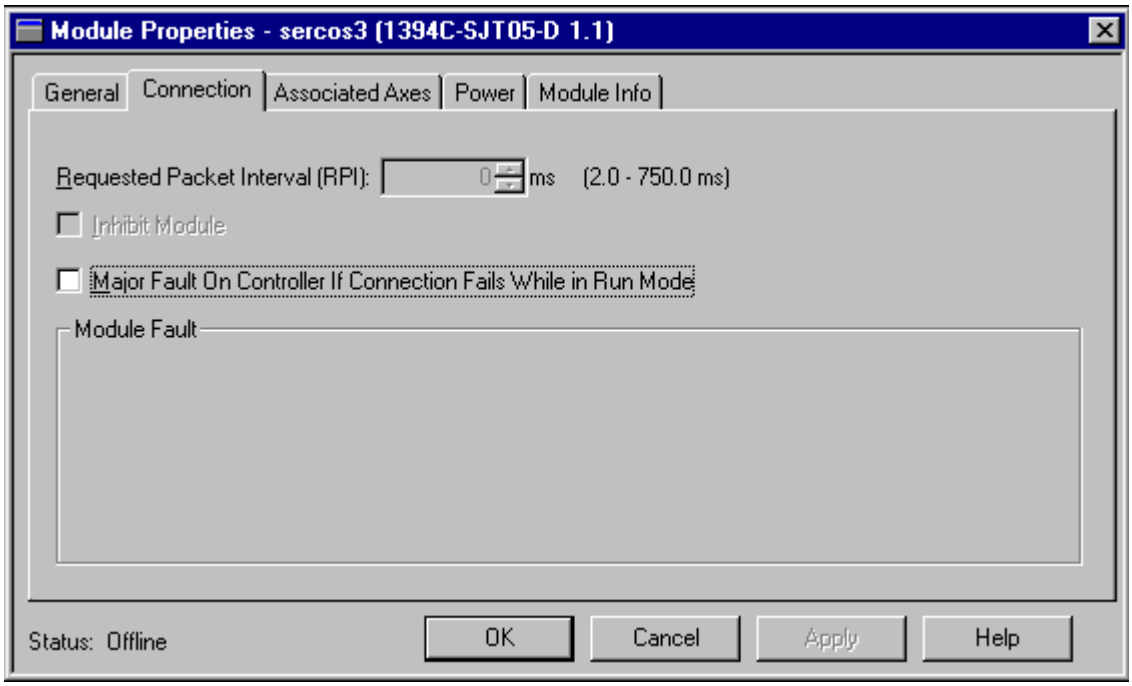


Figure 8.5 Module Properties - Connection Tab

On this tab, you can:

- choose to inhibit the module
- configure the controller so loss of the connection to this module causes a major fault
- view module faults

TIP The data on this tab comes directly from the controller. This tab displays information about the condition of the connection between the module and the controller.

Requested packet Interval

This field is disabled for all motion modules (e.g., 1756-MO2AE, 1756-M*xx*SE, and all 1394-, Ultra3000, Kinetix 6000, and 8720 modules).

Inhibit Module checkbox

Check/Uncheck this box to inhibit/uninhibit your connection to the module. Inhibiting the module causes the connection to the module to be broken.

IMPORTANT Inhibiting/uninhibiting connections applies mainly to direct connections, and not to the CNB module.

ATTENTION Inhibiting the module causes the connection to the module to be broken and may result in loss of data.

When you check this box and go online, the icon representing this module in the controller organizer displays the Attention Icon.

If you are:	Check this checkbox to:
offline	put a place holder for a module you are configuring
online	stop communication to a module. If you inhibit the module while you are online and connected to the module, the connection to the module is nicely closed. The module's outputs will go to the last configured Program mode state.If you inhibit the module while online but a connection to the module has not been established (perhaps due to an error condition or fault), the module is inhibited. The module status information will change to indicate that the module is 'Inhibited' and not 'Faulted'.If you uninhibit a module (clear the checkbox) while online, and no fault condition occurs, a connection is made to the module and the module is dynamically reconfigured (if you are the owner controller) with the configuration you have created for that module. If you are a listener (have chosen a “Listen Only” Communications Format), you can not re-configure the module. If you uninhibit a module while online and a fault condition occurs, a connection is not made to the module.

Major Fault on Controller if Connection Fails checkbox

Check this box to configure the controller so that failure of the connection to this module causes a major fault on the controller if the connection for the module fails.

Module Fault

Displays the fault code returned from the controller (related to the module you are configuring) and the text detailing the Module Fault that has occurred.

The following are common categories for errors:

- **Connection Request Error** - The controller is attempting to make a connection to the module and has received an error. The connection was not made.
- S**ervice Request Error** - The controller is attempting to request a service from the module and has received an error. The service was not performed successfully.
- **Module Configuration Invalid** - The configuration in the module is invalid. (This error is commonly caused by the Electronic Key Passed fault).
- **Electronic Keying Mismatch** - Electronic Keying is enabled and some part of the keying information differs between the.

Associated Axes Tab

Use this tab to configure the selected 1394*x*-SJT*xx*-D drive module by associating up to four AXIS_SERVO_DRIVE axis tags with configured axis modules.

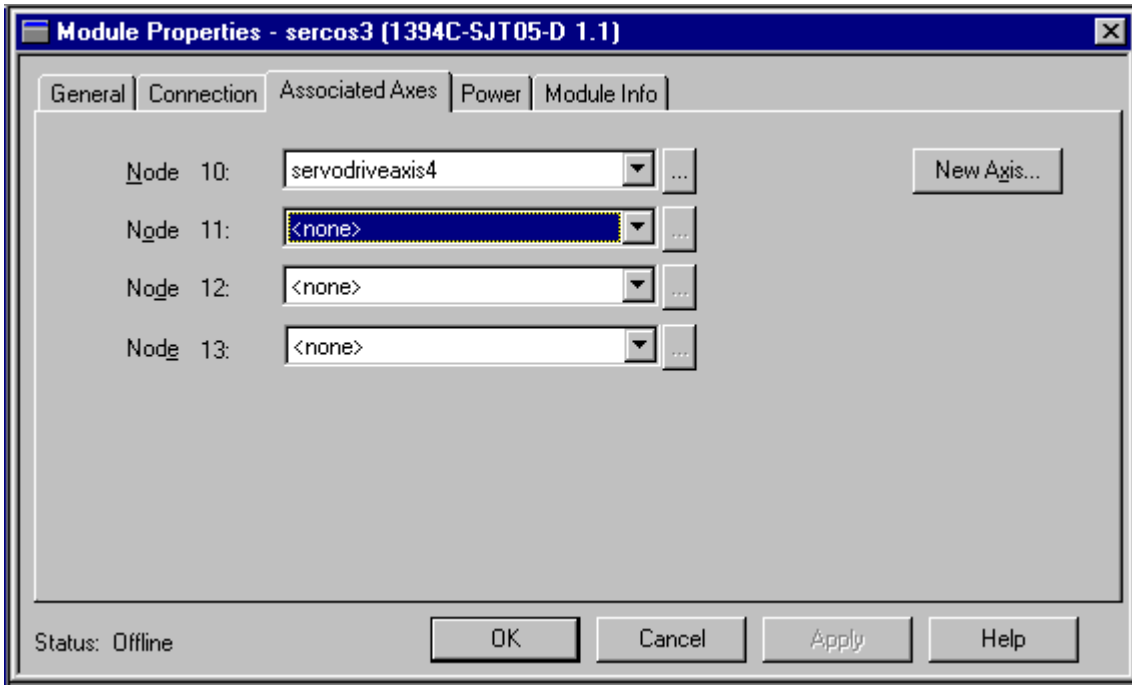


Figure 8.6 Module Properties - Associated Axis Tab

Node X0

Represents Axis 0 on the 1756-M*xx*SE SERCOS module. The node number is the sum of the Base Node set in the General page of this dialog box (X0) and the axis number (1). This field allows you to associate an AXIS_SERVO_DRIVE tag with Axis 0. This field transitions to a read only state while online. Click on the Ellipses (…) button to the right of this field to open the Axis properties dialog box for the associated axis.

Node X1

Represents Axis 1 on the 1756-M*xx*SE SERCOS module. The node number is the sum of the Base Node set in the General page of this dialog box (X0) and the axis number (1). This field allows you to associate an AXIS_SERVO_DRIVE tag with Axis 1. This field transitions to a read only state while online. Click on the Ellipses (…) button to the right of this field to open the Axis properties dialog box for the associated axis.

Node X2

Represents Axis 2 on the 1756-M*xx*SE SERCOS module The node number is the sum of the Base Node set in the General page of this dialog box (X0) and the axis number (2). This field allows you to associate an AXIS_SERVO_DRIVE tag with Axis 2. This field transitions to a read only state while online. Click on the Ellipses (…) button to the right of this field to open the Axis properties dialog box for the associated axis.

Node X3

Represents Axis 3 on the 1756-M*xx*SE SERCOS module The node number is the sum of the Base Node set in the General page of this dialog box (X0) and the axis number (3). This field allows you to associate an AXIS_SERVO_DRIVE tag with Axis 3. This field transitions to a read only state while online. Click on the Ellipses (…) button to the right of this field to open the Axis properties dialog box for the associated axis.

New Axis button

Click this button to navigate to the New Tag dialog to create an AXIS_SERVO_DRIVE tag to associate with one of the channels.

Power Tab Use this tab to select a bus regulator for your 1394*x*-SJT*xx*-D drive module.

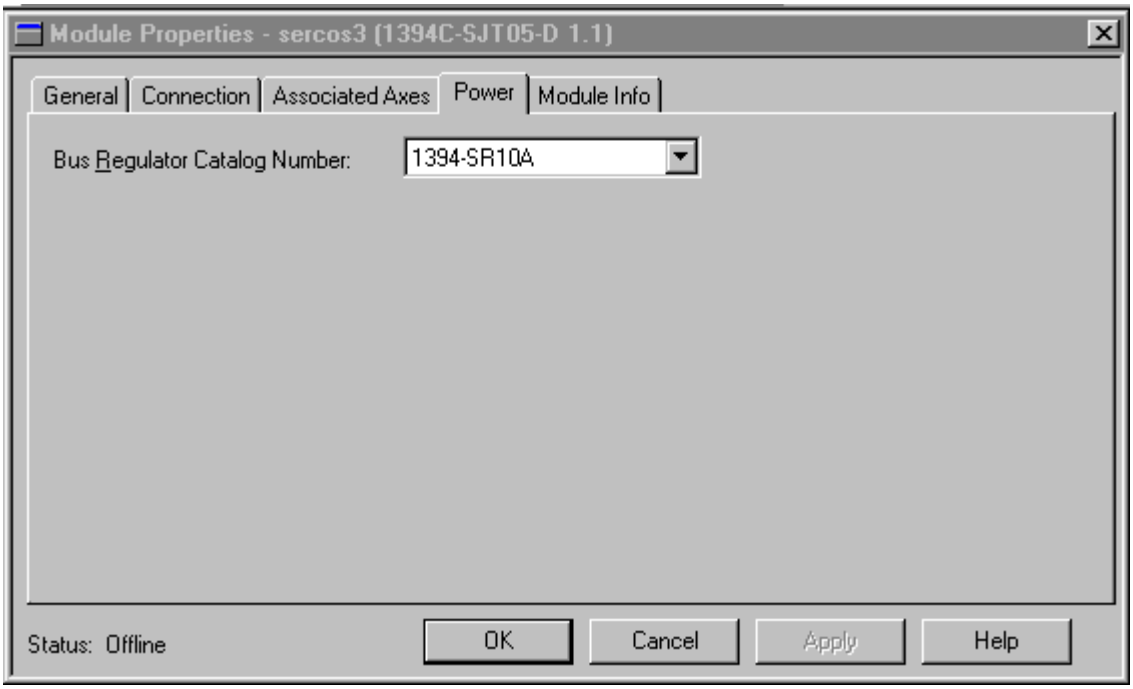


Figure 8.7 Module Properties - Power Tab

Bus Regulator ID

Select the catalog number that describes bus regulator device used by the 1394*x*-SJT*xx*-D drive module. Depending upon the Drive Module you have selected, one or more of the following are available:

Bus Regulator ID	Description
1394-SR10A	1400 Watt Resistor, for 5 and 10 kW modules
1394-SR9A	300 Watt External Shunt, No Fan, for 22 kW modules
1394-SR9AF	900 Watt External Shunt, No Fan, for 22 kW modules
1394-SR36A	1800 Watt External Shunt, No Fan, for 22 kW modules
1394-SR36AF	3600 Watt External Shunt, No Fan, for 22 kW modules
<none>	No bus regulator
Internal	The bus regulator is internal to the drive and need not be specified
Custom	A bus regulator not listed above

Module Info tab Use this tab to display identifying and status information about the 1394*x*-SJT*xx*-D drive module. It also allows you to refresh a module and reset a module to its power-up state.

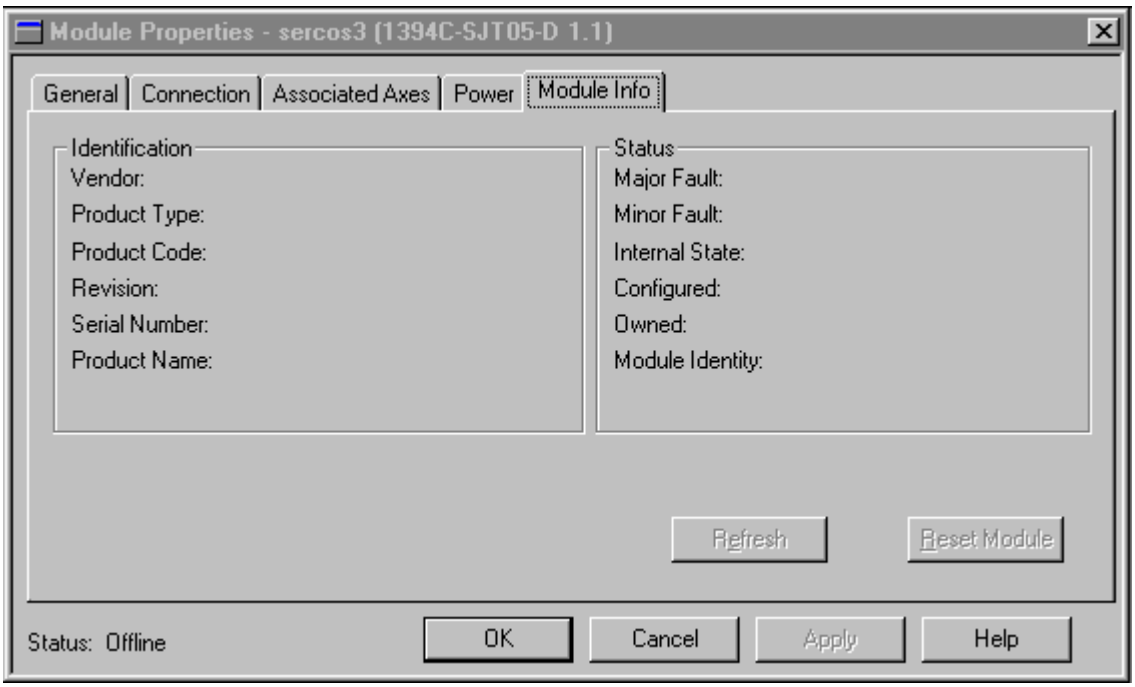


Figure 8.8 Module Properties - Module Info Tab

The information on this tab is not displayed if you are:

- offline, or
- currently creating a module

TIP The data on this tab comes directly from the module. If you selected a Listen-Only communication format when you created the module, this tab is not available.

Identification

Displays the module's:

- Vendor
- Product Type
- Product Code
- Revision
- Serial Number

Product Name

The name displayed in the Product Name field is read from the module. This name displays the series of the module.

Major/Minor Fault Status

Statuses are: EEPROM fault, Backplane fault, None.

Internal State Status

Displays the module's current operational state.

- Self-test
- Flash update
- Communication fault
- Unconnected
- Flash configuration bad
- Major Fault (please refer to "Major/Minor Fault Status" above)
- Run mode
- Program mode

(16#*xxxx*) unknown

If you selected the wrong module from the module selection tab, this field displays a hexadecimal value. A textual description of this state is only given when the module identity you provide is a match with the actual module.

Configured

Displays a yes or no value indicating whether the module has been configured by an owner controller connected to it. Once a module has been configured, it stays configured until the module is reset or power is cycled, even if the owner drops connection to the module. This information does not apply to adapters.

Owned

Displays a yes or no value indicating whether an owner controller is currently connected to the module. This information does not apply to adapters.

Module Identity

Displays:	If the module in the physical slot:
Match	agrees with what is specified on the General Tab. In order for the Match condition to exist, all of the following must agree: Vendor Module Type (the combination of Product Type and Product Code for a particular Vendor) Major Revision
Mismatch	does not agree with what is specified on the General Tab

This field does not take into account the Electronic Keying or Minor Revision selections for the module that were specified on the General Tab.

Refresh

Click on this button to refresh the tab with the new data from the module.

Reset Module

Click on this button to return a module to its power-up state by emulating the cycling of power.

ATTENTION

Resetting a module causes all connections to or through the module to be closed; this may result in loss of control.

Configuring an Ultra 3000 Drive

The Ultra3000 Digital Servo Drive with fiber optic SERCOS interface simplifies the integration of the Ultra3000 with the ControlLogix architecture by providing single point drive commissioning through RSLogix5000 software and reducing the control wiring to a single fiber optic cable.

You can initiate the configuration of an Ultra3000 drive module by either of two methods:

1. In the Controller Organizer, in the I/O Configuration branch, select a 1756-M*xx*SE motion module.

2. In the File menu, select New Component then Module.

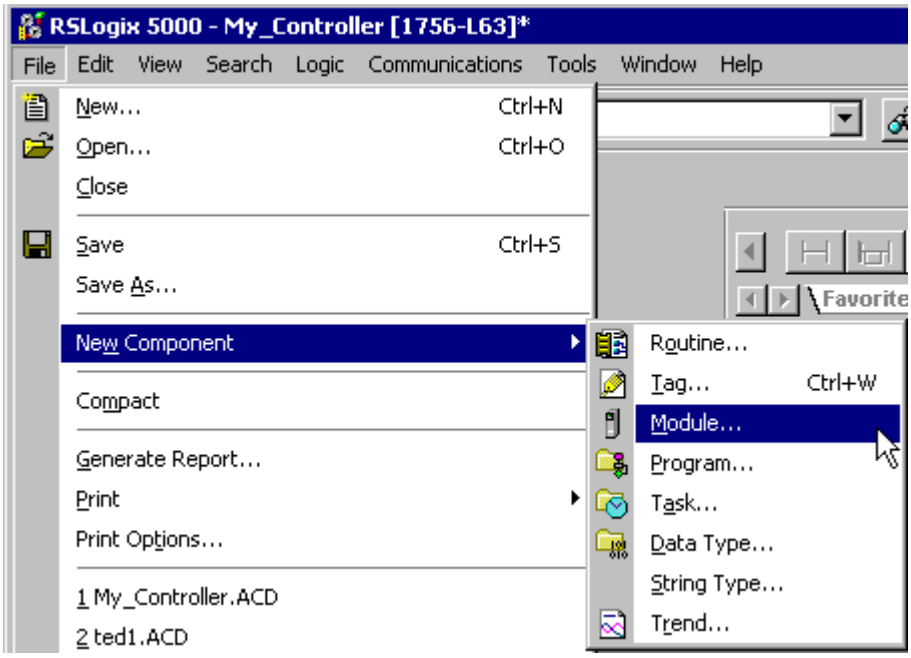


Figure 9.1 File Menu - New Component - Module

OR

3. Right click on the selected 1756-M*xx*SE in the I/O Configuration branch of the Controller Organizer.

4. Select New Module from the pop up menu.

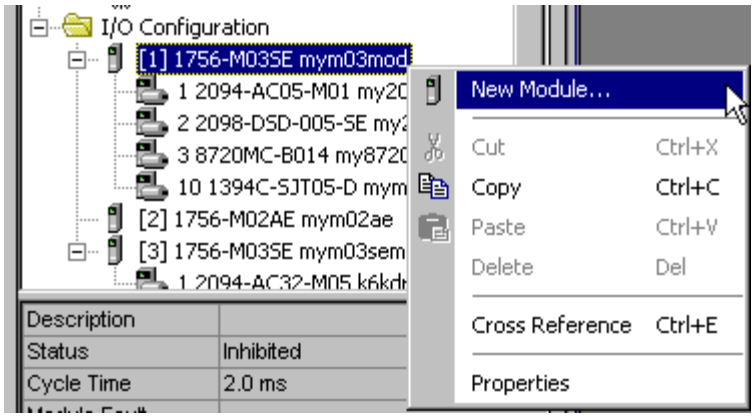


Figure 9.2 New Module Selection from Pop Up Menu

The following fields are displayed only if you are viewing this tab through the Create wizard.

Next> – Click this button to view the next Create wizard page.

<Back – Click this button to view the previous Create wizard page.

Finish>> – Click this button to close the Create wizard.

The Select Module Type dialog displays.

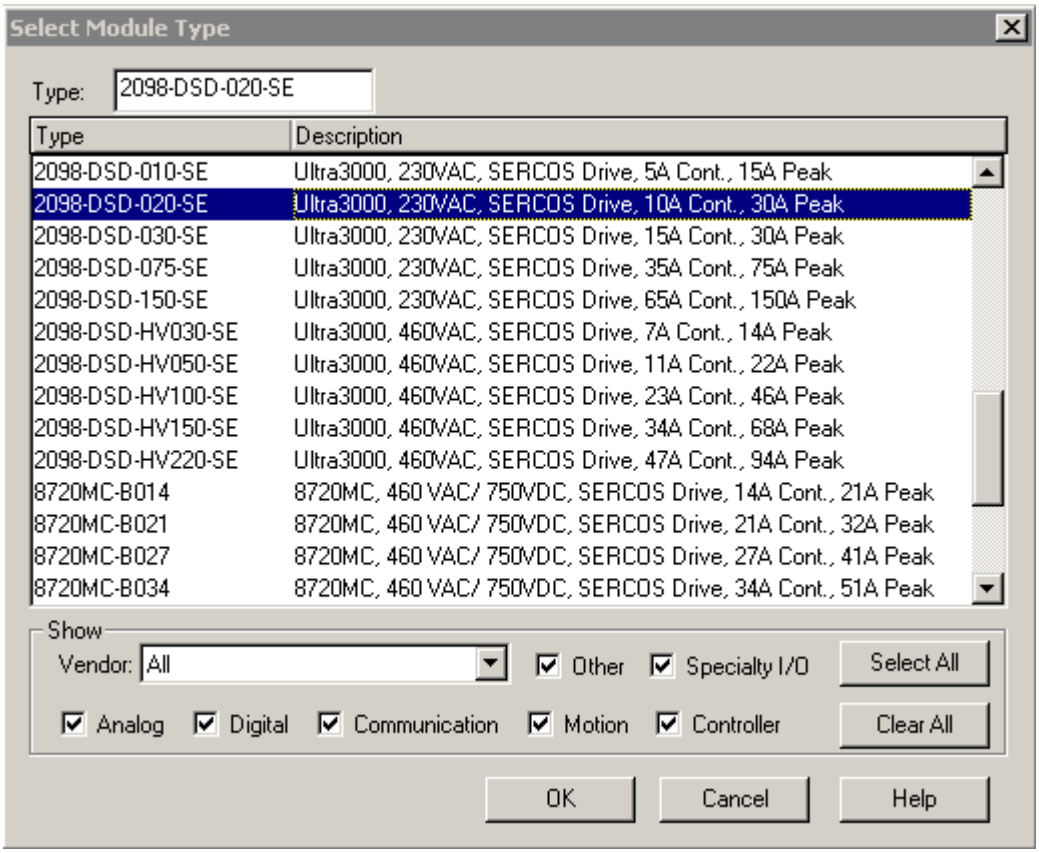

Select Module Type
Type: 2098-DSD-020-SE
Type
Description
2098-DSD-010-SE Ultra3000, 230VAC, SERCOS Drive, 5A Cont., 15A Peak
2098-DSD-020-SE Ultra3000, 230VAC, SERCOS Drive, 10A Cont., 30A Peak
2098-DSD-030-SE Ultra3000, 230VAC, SERCOS Drive, 15A Cont., 30A Peak
2098-DSD-075-SE Ultra3000, 230VAC, SERCOS Drive, 35A Cont., 75A Peak
2098-DSD-150-SE Ultra3000, 230VAC, SERCOS Drive, 65A Cont., 150A Peak
2098-DSD-HV030-SE Ultra3000, 460VAC, SERCOS Drive, 7A Cont., 14A Peak
2098-DSD-HV050-SE Ultra3000, 460VAC, SERCOS Drive, 11A Cont., 22A Peak
2098-DSD-HV100-SE Ultra3000, 460VAC, SERCOS Drive, 23A Cont., 46A Peak
2098-DSD-HV150-SE Ultra3000, 460VAC, SERCOS Drive, 34A Cont., 68A Peak
2098-DSD-HV220-SE Ultra3000, 460VAC, SERCOS Drive, 47A Cont., 94A Peak
8720MC-B014 8720MC, 460 VAC/ 750VDC, SERCOS Drive, 14A Cont., 21A Peak
8720MC-B021 8720MC, 460 VAC/ 750VDC, SERCOS Drive, 21A Cont., 32A Peak
8720MC-B027 8720MC, 460 VAC/ 750VDC, SERCOS Drive, 27A Cont., 41A Peak
8720MC-B034 8720MC, 460 VAC/ 750VDC, SERCOS Drive, 34A Cont., 51A Peak
Show
Vendor: All
Other
Specialty I/O
Select All
Analog
Digital
Communication
Motion
Controller
Clear All
OK
Cancel
Help

Figure 9.3 Select Module Type Window

5. In the Select Module Type dialog, select the desired drive module. The Ultra drives begin with the 2098 prefix.

6. Press the OK button to close the Select Module Type dialog. The Ultra Drive Create Wizard Module Properties dialog opens.

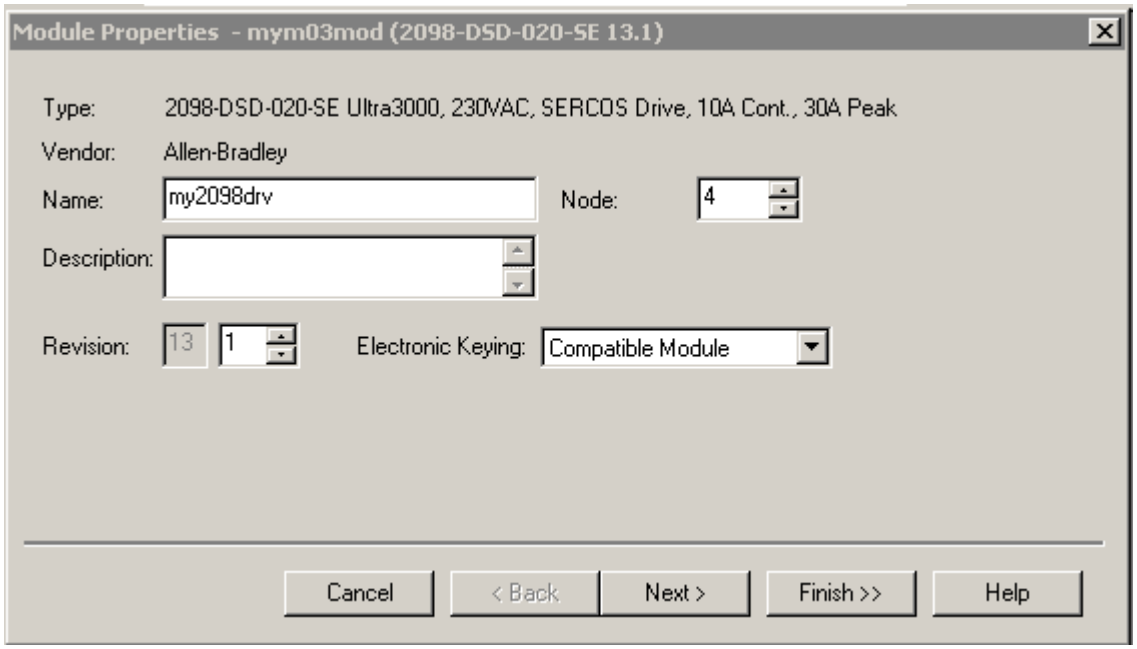


Figure 9.4 Module Properties Wizard Dialog - Naming the Drive

7. You must fill in a name for the drive; this is a required field. Fill in the responses for the other parameters as needed, then click the Next> button to advance to the next wizard screen or click on the Finish >> button to set the drive.

8. When you click the Finish> button. A new drive module displays beneath the selected 1756-M*xx*SE motion module.

Figure 9.5 Controller Organizer - New Drive

Editing the Ultra Drive Properties

The Module Properties for any of the Ultra3000 drives can be edited by highlighting the drive to be edited, right click with the mouse and selecting Properties.

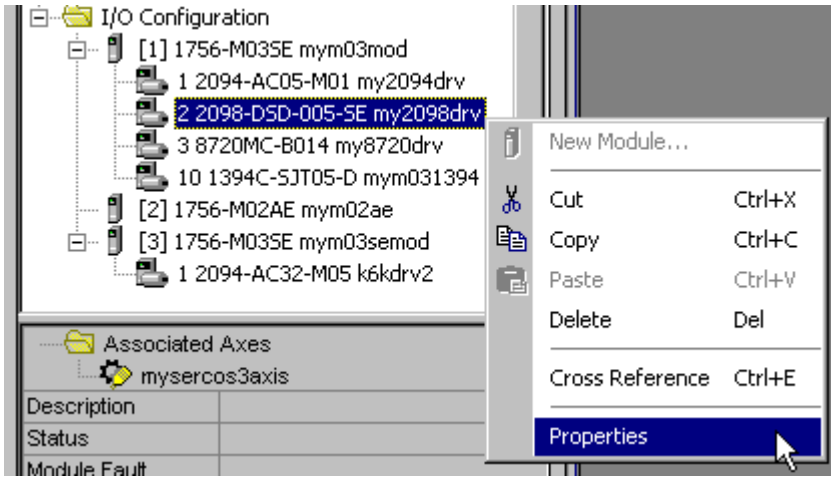


Figure 9.6 Accessing the Properties of the Drive

The Module Properties screen displays.

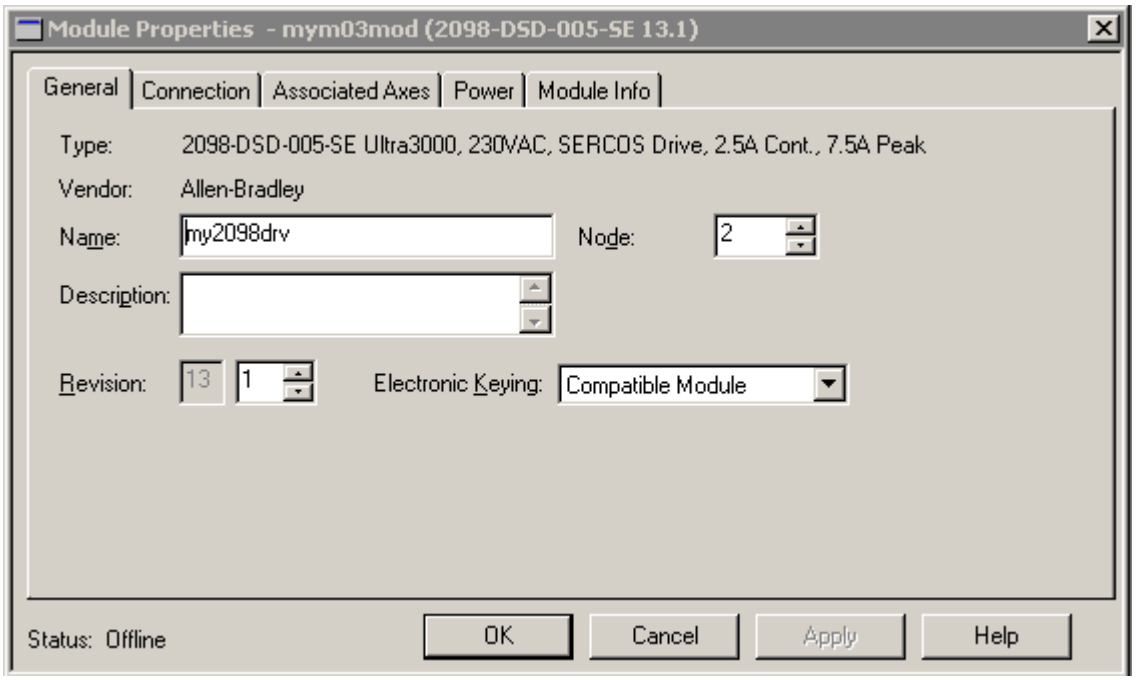


Figure 9.7 Module Properties - General Tab

General Tab The General Tab is where you edit the basic values for the Ultra drive.

Type

Displays the type and description of the module being created (read only).

Vendor

Displays the vendor of the module being created (read only).

Name

Enter the name of the module.

The name must be IEC 1131-3 compliant. This is a required field and must be completed, otherwise you receive an error message when you exit this tab. An error message is also displayed if a duplicate name is detected, or you enter an invalid character. If you exceed the maximum name length allowed by the software, the extra character(s) are ignored.

Description

Enter a description for the module here, up to 128 characters. You can use any printable character in this field. If you exceed the maximum length, the software ignores any extra character(s).

Node

Select the network node number of the module on the network. Valid values include those network nodes not in use between 1 to 99.

Revision

Select the minor revision number of your module.

The revision is divided into the major revision and minor revision. The major revision displayed statically is chosen on the Select Module Type dialog.

The major revision is used to indicate the revision of the interface to the module. The minor revision is used to indicate the firmware revision.

Slot

Enter the slot number in which the module resides.

Electronic Keying

Select one of these keying options for your module during initial module configuration:

- Exact Match - all of the parameters described below must match or the inserted module will reject the connection.
- Compatible Modules – The following criteria must be met, or else the inserted module will reject the connection:
  - The Module Types, Catalog Number, and Major Revision must match.
  - The Minor Revision of the physical module must be equal to or greater than the one specified in the software.
- Disable Keying – Controller does not employ keying at all.

ATTENTION

Changing the Electronic Keying selections may cause the connection to the module to be broken and may result in a loss of data.

Be extremely cautious when using this option; if used incorrectly, this option can lead to personal injury or death, property damage or economic loss.

When you insert a module into a slot in a ControlLogix chassis, RSLogix 5000 compares the following information for the inserted module to that of the configured slot:

- Vendor
- Product Type
- Catalog Number
- Major Revision
- Minor Revision

This feature prevents the inadvertent insertion of the wrong module in the wrong slot.

Status

Displays the status the controller has about the module:

This status:	Indicates:
Standby	A transient state that occurs when shutting down.
Faulted	The controller is unable to communicate with the module. When the status is Faulted, the Connection tab displays the fault.
Validating	A transient state that occurs before connecting to the module.
Connecting	A state that occurs while the connection(s) are being established to the module.
Running	The module is communicating and everything is working as expected.
Shutting Down	The connections are closing.
Inhibited	The connection to the module is inhibited.
Waiting	The connection to this module has not yet been made due to one of the following: • its parent has not yet made a connection to it • its parent is inhibited§ • its parent is faulted
Offline	You are not online.

Connection Tab Use this tab to define controller to module behavior.

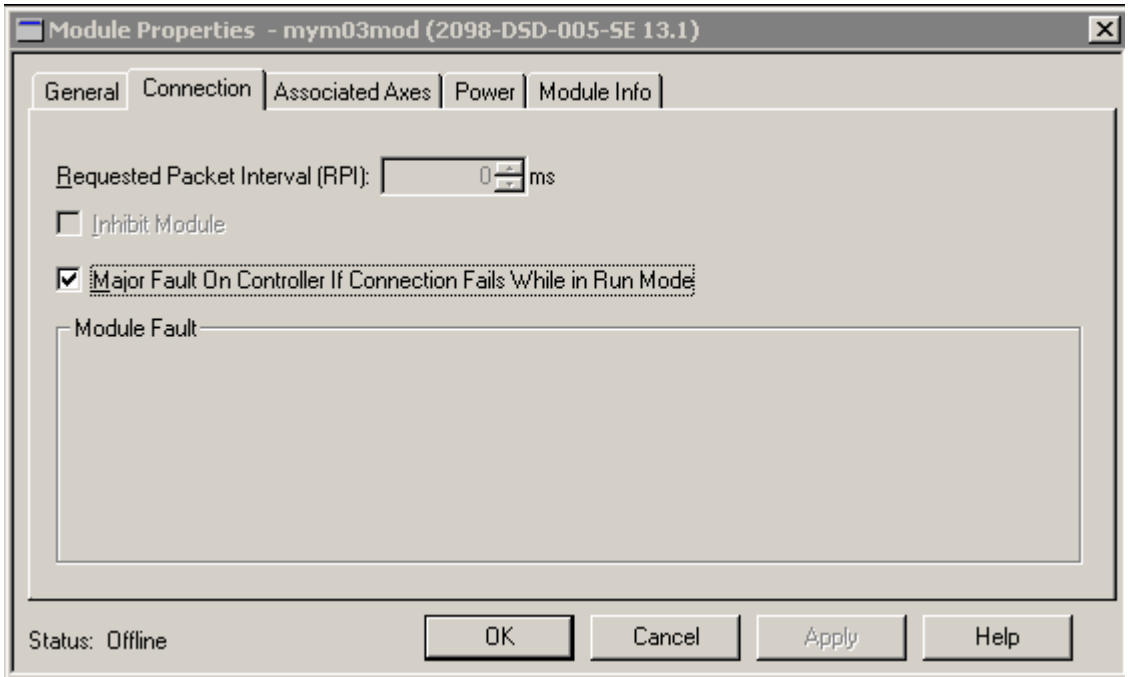


Figure 9.8 Module Properties - Connection Tab

On this tab, you can:

- Select a requested packet interval.
- Choose to inhibit the module.
- Configure the controller so loss of the connection to this module causes a major fault.
- View module faults.

TIP The data on this tab comes directly from the controller. This tab displays information about the condition of the connection between the module and the controller.

Requested Packet Interval

This field is disabled for all motion modules (e.g., 1756-MO2AE, 1756-M*xx*SE, and all 1394-, Ultra3000, Kinetix 6000, and 8720 modules).

Inhibit Module

Check/Uncheck this box to inhibit/uninhibit your connection to the module. Inhibiting the module causes the connection to the module to be broken.

Note: Inhibiting/uninhibiting connections applies mainly to direct connections, and not to the CNB module.

Note: A FLEX I/O module using rack communication cannot be inhibited; the Inhibit checkbox on the Connection tab is disabled in this case.

ATTENTION Inhibiting the module causes the connection to the module to be broken and may result in loss of data.

When you check this box and go online, the icon representing this module in the controller organizer displays the Warning Icon.

If you are:	Check this checkbox to:
offline	put a place holder for a module you are configuring
online	stop communication to a module • If you inhibit the module while you are online and connected to the module, the connection to the module is nicely closed. The module's outputs go to the last configured Program mode state. • If you inhibit the module while online but a connection to the module has not been established (perhaps due to an error condition or fault), the module is inhibited. The module status information changes to indicate that the module is 'Inhibited' and not 'Faulted'. • If you uninhibit a module (clear the checkbox) while online, and no fault condition occurs, a connection is made to the module and the module is dynamically reconfigured (if you are the owner controller) with the configuration you have created for that module. If you are a listener (have chosen a "Listen Only" Communications Format), you can not re-configure the module. • If you uninhibit a module while online and a fault condition occurs, a connection is not made to the module.

Major Fault on Controller if Connection Fails checkbox

Check this box to configure the controller so that failure of the connection to this module causes a major fault on the controller if the connection for the module fails.

Module Fault

Displays the fault code returned from the controller (related to the module you are configuring) and the text detailing the Module Fault that has occurred.

The following are common categories for errors:

- **Connection Request Error** - The controller is attempting to make a connection to the module and has received an error. The connection was not made.
- **Service Request Error** - The controller is attempting to request a service from the module and has received an error. The service was not performed successfully.
- **Module Configuration Invalid** - The configuration in the module is invalid. (This error is commonly caused by the Electronic Key Passed fault).

- **Electronic Keying Mismatch** - Electronic Keying is enabled and some part of the keying information differs between the software and the module.

Associated Axes Tab (Ultra3000 Drives)

Use this tab to configure the selected 1756-M*xx*SE motion module by associating axis tags (of the type AXIS_SERVO_DRIVE) with nodes available on the module.

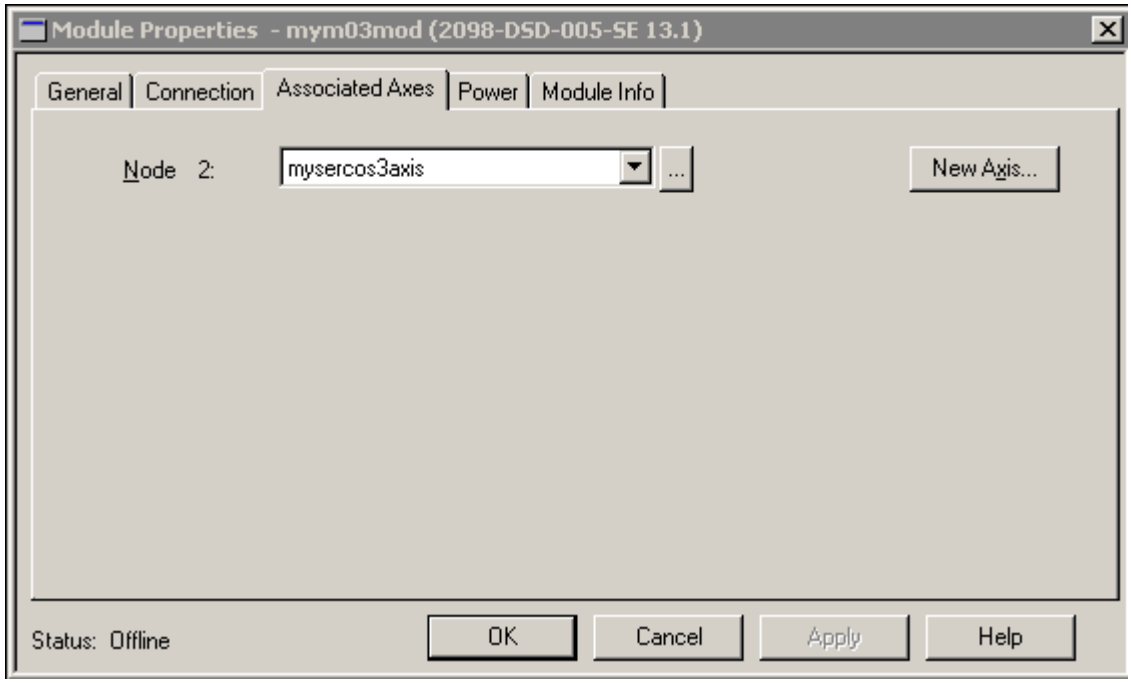


Figure 9.9 Module Properties - Associated Axes Tab

Node

Displays the selected node of the Ultra3000 drive, as selected on the General tab. This field allows you to associate an AXIS_SERVO_DRIVE tag with the driver's node.

Note: This field is read-only while you are online.

Ellipsis (...)

Click on this button to access the Axis Properties dialog for the associated axis.

New Axis

Click on this button to access the New Tag dialog, with the scope, data type, and produced settings appropriate for a produced axis tag.

Power Tab - Ultra Drive Use this tab to select a bus regulator for your Ultra 3000 drive module.

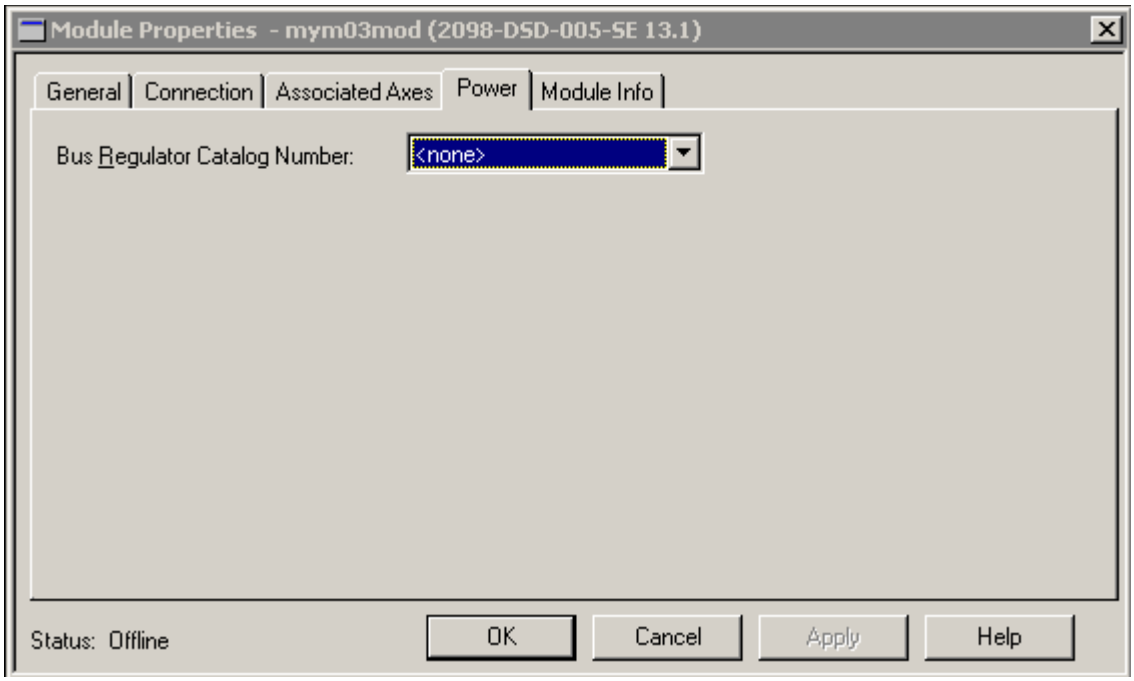


Figure 9.10 Module Properties - Power Tab

Note: This parameter does not apply to the Ultra3000 SERCOS drives. The only available selection in the Bus Regulator ID pull-down menu is <none>.

Bus Regulator ID

Select the catalog number that describes bus regulator device used by the Ultra 3000 drive module. Depending upon the Drive Module you have selected, one or more of the following are available:

Note: This parameter does not apply to the Ultra3000 SERCOS drives. The only available selection in the pull-down menu is <none>.

Module Info Tab The Module Info Tab displays module and status information about the module. It also allows you to reset a module to its power-up state.

The information on this tab is not displayed if you are either offline or currently creating a module

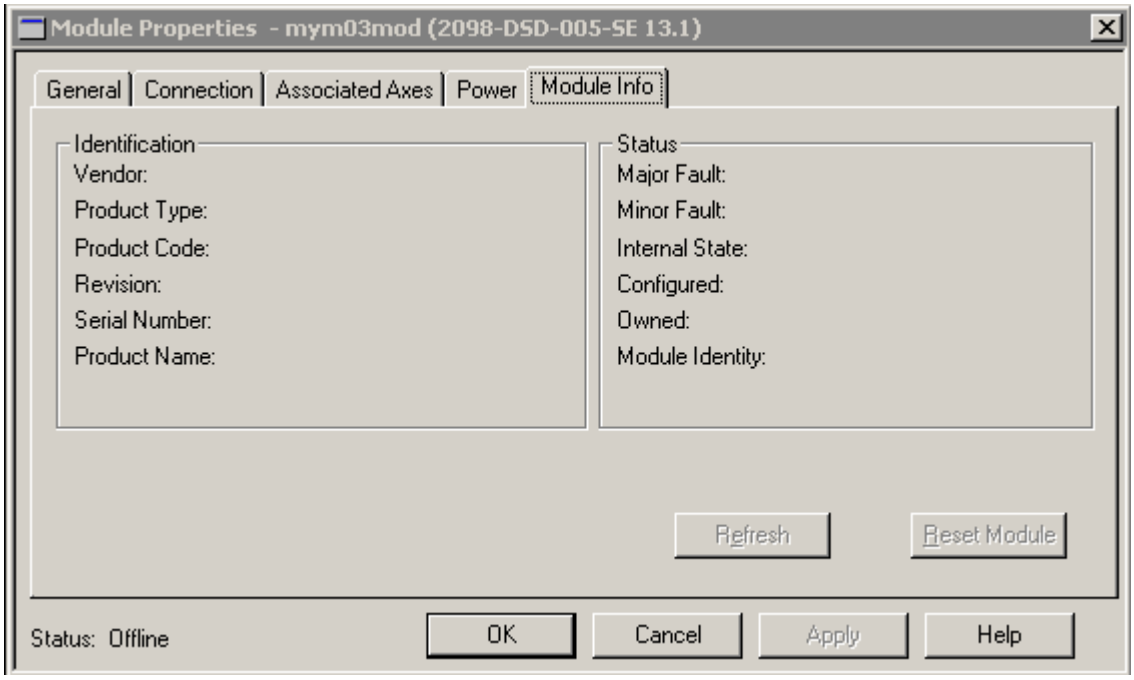


Figure 9.11 Module Properties - Module Info

TIP You can use this tab to determine the identity of the module.

The data on this tab comes directly from the module. If you selected a Listen-Only communication format when you created the module, this tab is not available.

- Refresh to display new data from the module.
- Reset Module to return the module to its power-up state by emulating the cycling of power. By doing this, you also clear all faults.

Identification

Displays the module's:

- Vendor
- Product Type
- Product Code
- Revision
- Serial Number

- Product Name

The name displayed in the Product Name field is read from the module. This name displays the series of the module. If the module is a 1756-L1 module, this field displays the catalog number of the memory expansion board (this selection applies to any controller catalog number even if additional memory cards are added.

Major/Minor Fault Status

If you are configuring a:	This field displays one of the following:
digital module	EEPROM fault Backplane fault None
analog module	Comm. Lost with owner Channel fault None
Any other module	None Unrecoverable Recoverable

Internal State Status

Displays the module's current operational state.

- Self-test
- Flash update
- Communication fault
- Unconnected
- Flash configuration bad
- Major Fault (please refer to "Major/Minor Fault Status" above)
- Run mode
- Program mode
- (16#xxxx) unknown

If you selected the wrong module from the module selection tab, this field displays a hexadecimal value. A textual description of this state is only given when the module identity you provide is a match with the actual module.

Configured

Displays a yes or no value indicating whether the module has been configured by an owner controller connected to it. Once a module has been configured, it stays configured until the module is reset or power is cycled, even if the owner drops connection to the module.

This information applies to I/O modules only and does not apply to adapters, scanners, bridges, or other communications modules.

Owned

Displays a yes or no value indicating whether an owner controller is currently connected to the module. This information applies to I/O modules only and does not apply to adapters, scanners, bridges, or other communications modules.

Module Identity

Displays:	If the physical module:
Match	agrees with what is specified on the General Tab order for the Match condition to exist, all of the following must agree: • Vendor • Module Type (the combination of Product Type and Product Code for a particular Vendor) • Major Revision
Mismatch	does not agree with what is specified on the General Tab

This field does not take into account the Electronic Keying or Minor Revision selections for the module that were specified on the General Tab.

> **Note:** The Generic modules, such as the 1756-MODULE, always show a Mismatch because the configured Generic Key does not match any target device.

Reset Module

Click on this button to return a module to its power-up state by emulating the cycling of power.

Resetting a module causes all connections to or through the module to be closed, and this may result in loss of control.

> **Note:** The following modules return an error if a reset is attempted:

- 1756-L1 ControlLogix5550 Programmable Controller
- 1336T AC Vector Drive
- 1395 Digital DC Drive

> **Note:** A controller cannot be reset.

Refresh

Click on this button to refresh the tab with new data from the module.

If you are online in Program, Remote Program or Remote Run mode, and this controller is the owner controller, and you have changed the module's configuration in the software, then when you click the Apply or the OK button, the information is automatically sent to the controller. The controller tries to send the information to the module (if the module's connection is not inhibited). If you don't click Apply, your changes are not sent to the controller.

Configuring a Kinetix 6000 Drive

The Kinetix 6000 Digital Servo Drive with fiber optic SERCOS interface simplifies the integration of the Kinetix 6000 with the ControlLogix architecture by providing single point drive commissioning through RSLogix5000 software and reducing the control wiring to a single fiber optic cable.

You can initiate the configuration of an Kinetix 6000 drive module by either of two methods.

The first method:

1. In the Controller Organizer, in the I/O Configuration branch, select a 1756-M*xx*SE motion module.

2. In the File menu, select New Component then Module.

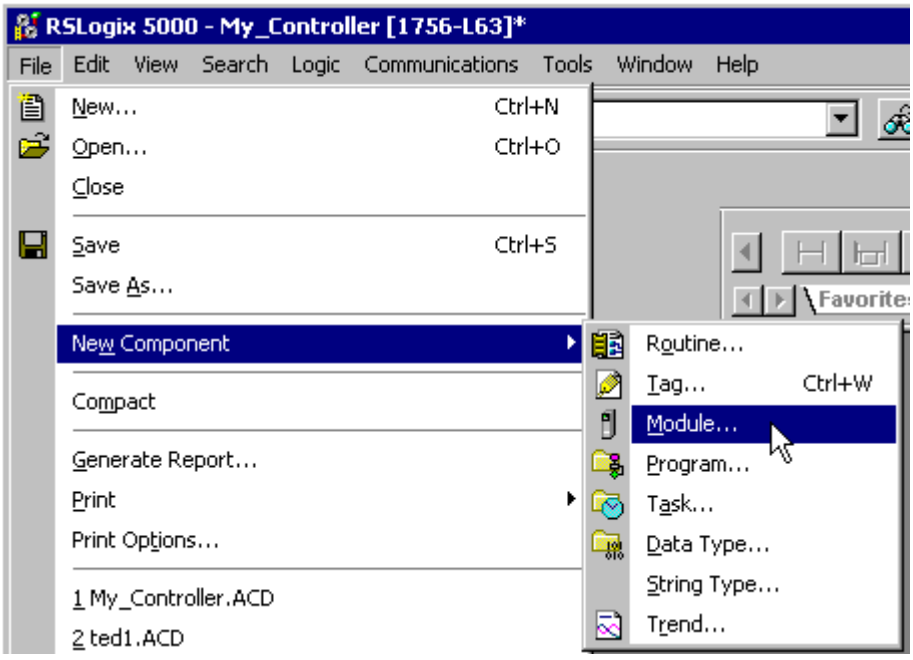


Figure 10.1 File Menu - New Component - Module

The second method:

1. Right click on the selected 1756-M*xx*SE in the I/O Configuration branch of the Controller Organizer.

2. Select New Module from the pop up menu.

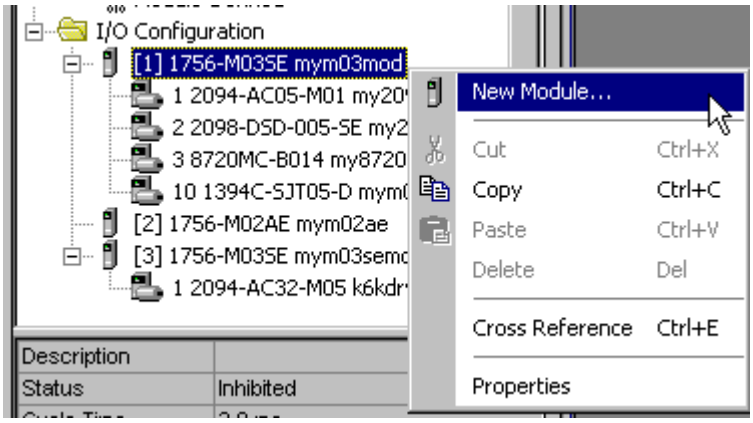


Figure 10.2 New Module Selection from Pop Up Menu

The Select Module Type dialog displays.

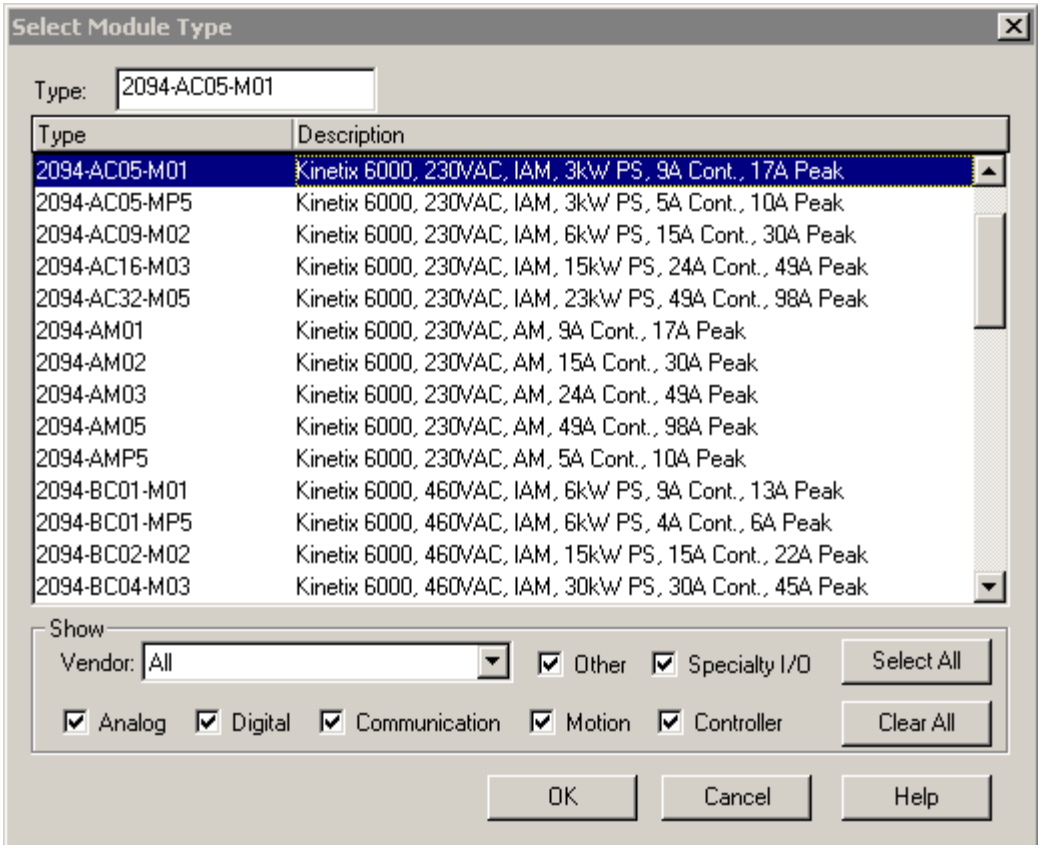

Select Module Type
Type: 2094-AC05-M01
Type
Description
2094-AC05-M01 Kinetix 6000, 230VAC, IAM, 3kW PS, 9A Cont., 17A Peak
2094-AC05-MP5 Kinetix 6000, 230VAC, IAM, 3kW PS, 5A Cont., 10A Peak
2094-AC09-M02 Kinetix 6000, 230VAC, IAM, 6kW PS, 15A Cont., 30A Peak
2094-AC16-M03 Kinetix 6000, 230VAC, IAM, 15kW PS, 24A Cont., 49A Peak
2094-AC32-M05 Kinetix 6000, 230VAC, IAM, 23kW PS, 49A Cont., 98A Peak
2094-AM01 Kinetix 6000, 230VAC, AM, 9A Cont., 17A Peak
2094-AM02 Kinetix 6000, 230VAC, AM, 15A Cont., 30A Peak
2094-AM03 Kinetix 6000, 230VAC, AM, 24A Cont., 49A Peak
2094-AM05 Kinetix 6000, 230VAC, AM, 49A Cont., 98A Peak
2094-AMP5 Kinetix 6000, 230VAC, AM, 5A Cont., 10A Peak
2094-BC01-M01 Kinetix 6000, 460VAC, IAM, 6kW PS, 9A Cont., 13A Peak
2094-BC01-MP5 Kinetix 6000, 460VAC, IAM, 6kW PS, 4A Cont., 6A Peak
2094-BC02-M02 Kinetix 6000, 460VAC, IAM, 15kW PS, 15A Cont., 22A Peak
2094-BC04-M03 Kinetix 6000, 460VAC, IAM, 30kW PS, 30A Cont., 45A Peak
Show
Vendor: All
Other
Specialty I/O
Select All
Analog
Digital
Communication
Motion
Controller
Clear All
OK
Cancel
Help

Figure 10.3 Select Module Type Window

3. In the Select Module Type dialog, select the desired drive module. The Kinetix 6000 drives begin with the 2094 prefix.

4. Press the OK button to close the Select Module Type dialog. The Kinetix 6000 Drive Create Wizard Module Properties dialog opens.

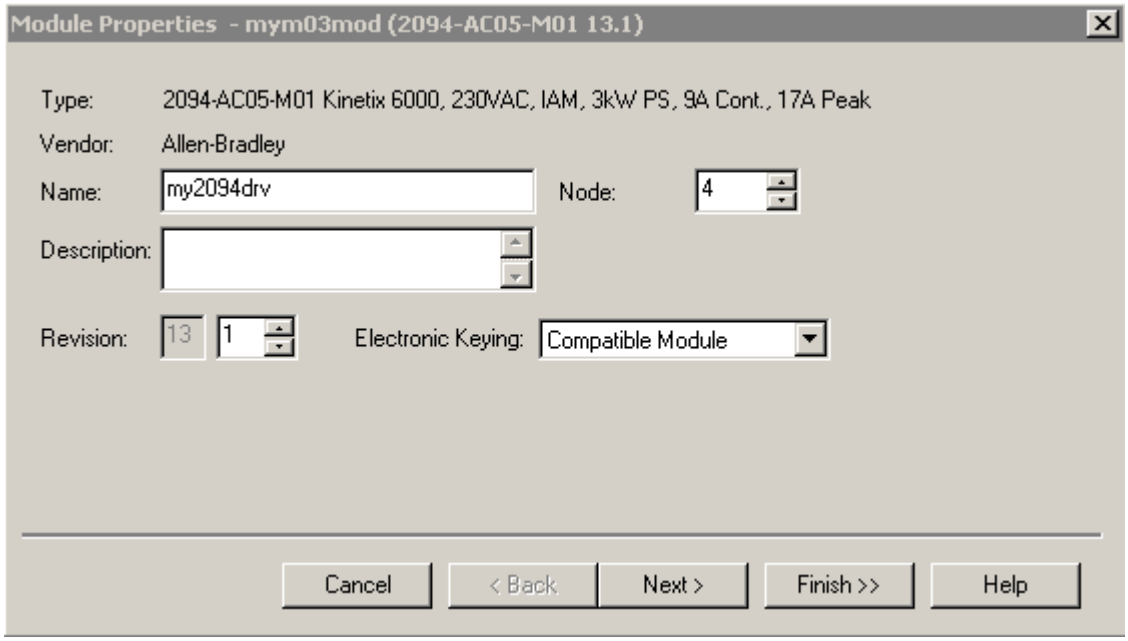


Figure 10.4 Module Properties Wizard Dialog - Naming the Drive

You must fill in a name for the drive; this is a required field. Fill in the responses for the other parameters as needed, then click the Next> button to advance to the next wizard screen or click on the Finish>> button to add the drive to your Controller Organizer.

5. A new drive module displays beneath the selected 1756-M*xx*SE motion module.

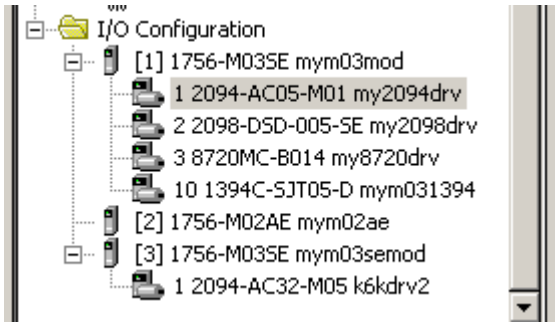


Figure 10.5 Controller Organizer - New Kinetix Drive

Editing the Kinetix Drive Properties

The Module Properties for any of the Kinetix 6000 drives can be edited by highlighting the drive to be edited, right click with the mouse and selecting Properties.

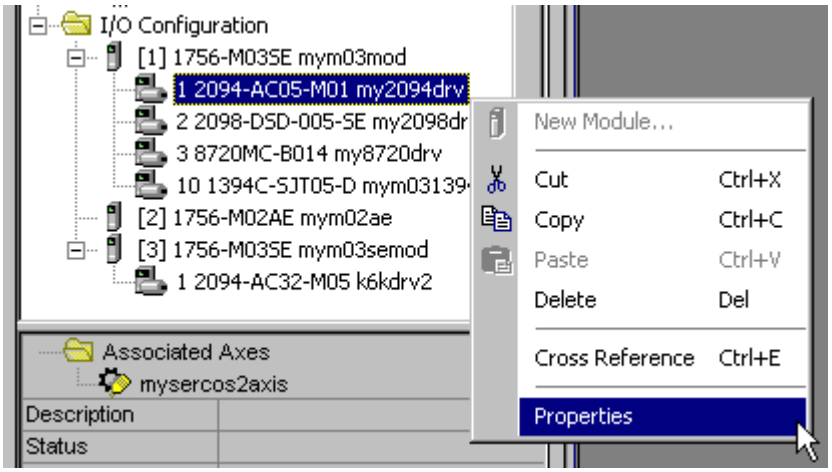


Figure 10.6 Accessing the Properties of the Drive

The Module Properties screen displays.

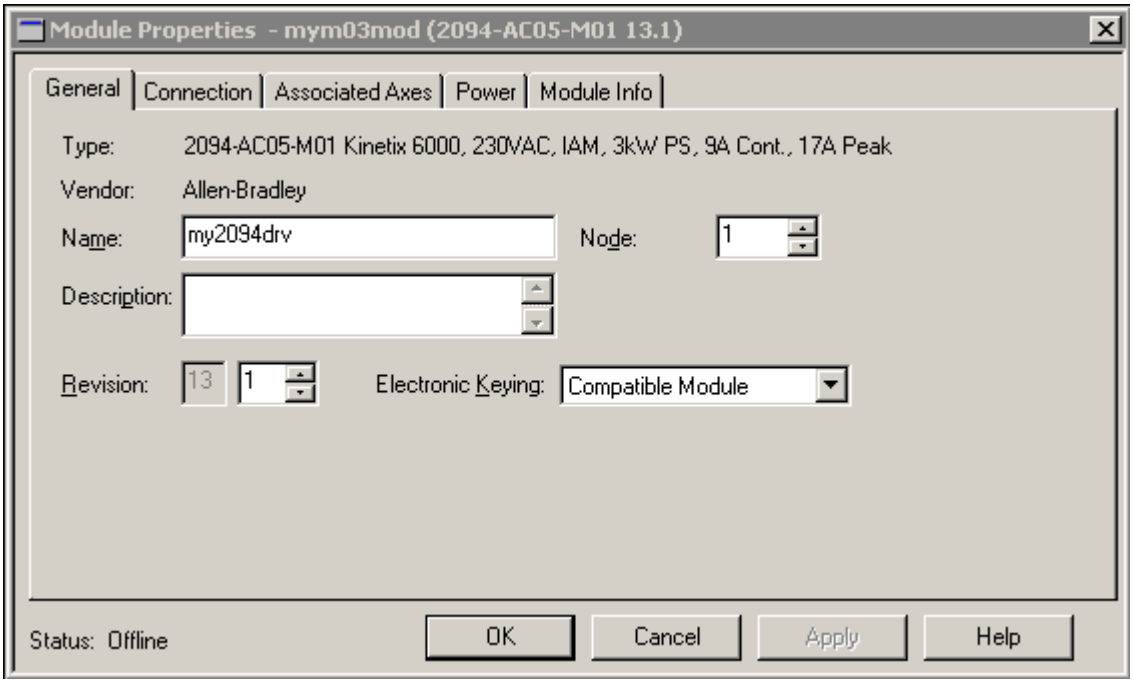


Figure 10.7 Module Properties - General Tab

General Tab The General Tab is where you edit the basic values for the Ultra drive.

Type

Displays the type and description of the module being created (read only).

Vendor

Displays the vendor of the module being created (read only).

Name

Enter a name for the module.

The name must be IEC 1131-3 compliant. This is a required field and must be completed, otherwise you receive an error message when you exit this tab. An error message is also displayed if a duplicate name is detected, or you enter an invalid character. If you exceed the maximum name length allowed by the software, the extra character(s) are ignored.

Description

Enter a description for the module here, up to 128 characters. You can use any printable character in this field. If you exceed the maximum length, the software ignores the extra character(s).

Node

Enter the SERCOS node number of the drive module. Valid values include those nodes not already in use. You can determine the SERCOS node number by checking the position of the rotary switch on the associated drive. IAM has node switch which specifies remaining slot location node addresses.

Revision

Select the minor revision number of your module.

The revision is divided into the major revision and minor revision. The major revision displayed statically is chosen on the Select Module Type dialog.

The major revision is used to indicate the revision of the interface to the module. The minor revision is used to indicate the firmware revision.

Electronic Keying

Select one of these keying options for your module during initial module configuration:

- Exact Match - all of the parameters described below must match or the inserted module will reject the connection.
- Compatible Modules – The following criteria must be met, or else the inserted module will reject the connection:
  - The Module Types, Catalog Number, and Major Revision must match.
  - The Minor Revision of the physical module must be equal to or greater than the one specified in the software.
- Disable Keying – the controller does not employ keying at all.

ATTENTION

Changing the Electronic Keying selection may cause the connection to the module to be broken and may result in a loss of data.

Be extremely cautious when using this option; if used incorrectly, this option can lead to personal injury or death, property damage or economic loss.

Status

Displays the status the controller has about the module:

This status:	Indicates:
Standby	A transient state that occurs when shutting down.
Faulted	The controller is unable to communicate with the module. When the status is Faulted, the Connection tab displays the fault.
Validating	A transient state that occurs before connecting to the module.
Connecting	A state that occurs while the connection(s) are being established to the module.
Running	The module is communicating and everything is working as expected.
Shutting Down	The connections are closing.

This status:	Indicates:
Inhibited	The connection to the module is inhibited.
Waiting	The connection to this module has not yet been made due to one of the following: • its parent has not yet made a connection to it • its parent is inhibited§ • its parent is faulted
Offline	You are not online.

Connection Tab Use this tab to define controller to module behavior.

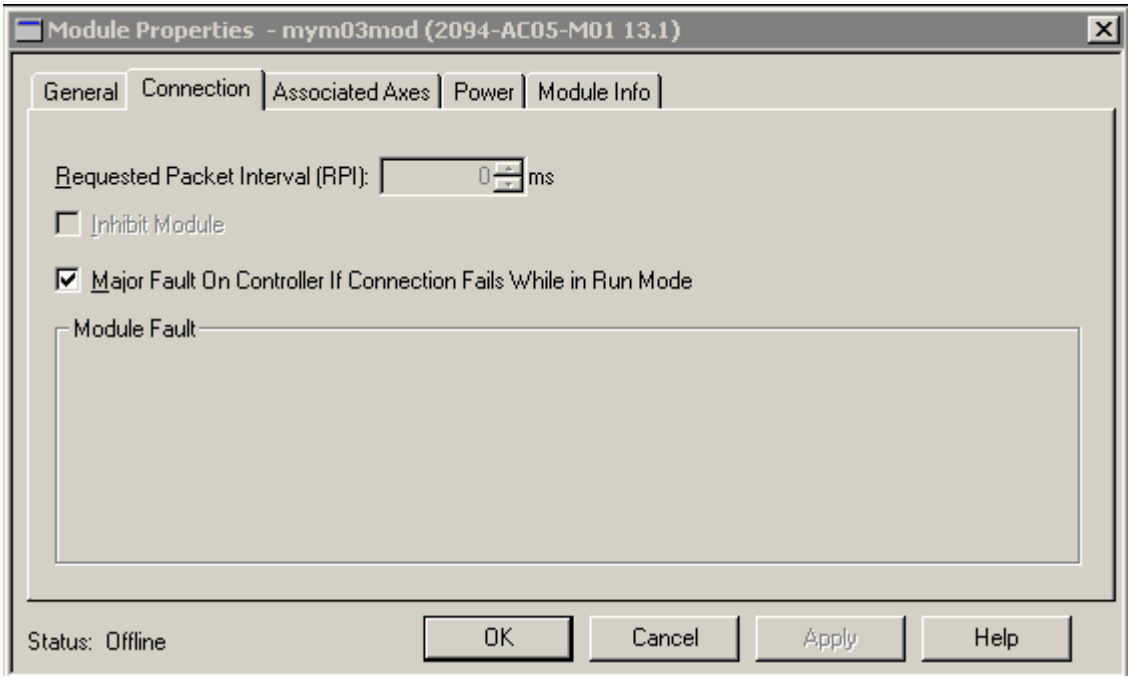


Figure 10.8 Module Properties - Connection Tab

On this tab, you can:

- Requested Packet Interval – does not pertain to this drive.
- Choose to inhibit the module.
- Configure the controller so loss of the connection to this module causes a major fault.
- View module faults.

TIP The data on this tab comes directly from the controller. This tab displays information about the condition of the connection between the module and the controller.

Requested Packet Interval

This field is disabled for all motion modules (e.g., 1756-M02AE, 1756-M*xx*SE, and all 1394- and Ultra3000, Kinetix 6000, and 8720 drives).

Inhibit Module

Check/Uncheck this box to inhibit/uninhibit your connection to the module. Inhibiting the module causes the connection to the module to be broken.

Note: Inhibiting/uninhibiting connections applies mainly to direct connections, and not to the CNB module.

Note: A FLEX I/O module using rack communication cannot be inhibited; the Inhibit checkbox on the Connection tab is disabled in this case.

ATTENTION

Inhibiting the module causes the connection to the module to be broken and may result in loss of data.

When you check this box and go online, the icon representing this module in the controller organizer displays the Warning Icon.

If you are:	Check this checkbox to:
offline	put a place holder for a module you are configuring
online	stop communication to a module • If you inhibit the module while you are online and connected to the module, the connection to the module is nicely closed. The module's outputs go to the last configured Program mode state. • If you inhibit the module while online but a connection to the module has not been established (perhaps due to an error condition or fault), the module is inhibited. The module status information changes to indicate that the module is 'Inhibited' and not 'Faulted'. • If you uninhibit a module (clear the checkbox) while online, and no fault condition occurs, a connection is made to the module and the module is dynamically reconfigured (if you are the owner controller) with the configuration you have created for that module. If you are a listener (have chosen a "Listen Only" Communications Format), you can not re-configure the module. • If you uninhibit a module while online and a fault condition occurs, a connection is not made to the module.

Major Fault on Controller if Connection Fails checkbox

Check this box to configure the controller so that failure of the connection to this module causes a major fault on the controller if the connection for the module fails.

Module Fault

Displays the fault code returned from the controller (related to the module you are configuring) and the text detailing the Module Fault that has occurred.

The following are common categories for errors:

- **Connection Request Error** - The controller is attempting to make a connection to the module and has received an error. The connection was not made.
- **Service Request Error** - The controller is attempting to request a service from the module and has received an error. The service was not performed successfully.
- **Module Configuration Invalid** - The configuration in the module is invalid. (This error is commonly caused by the Electronic Key Passed fault).
- **Electronic Keying Mismatch** - Electronic Keying is enabled and some part of the keying information differs between the software and the module.

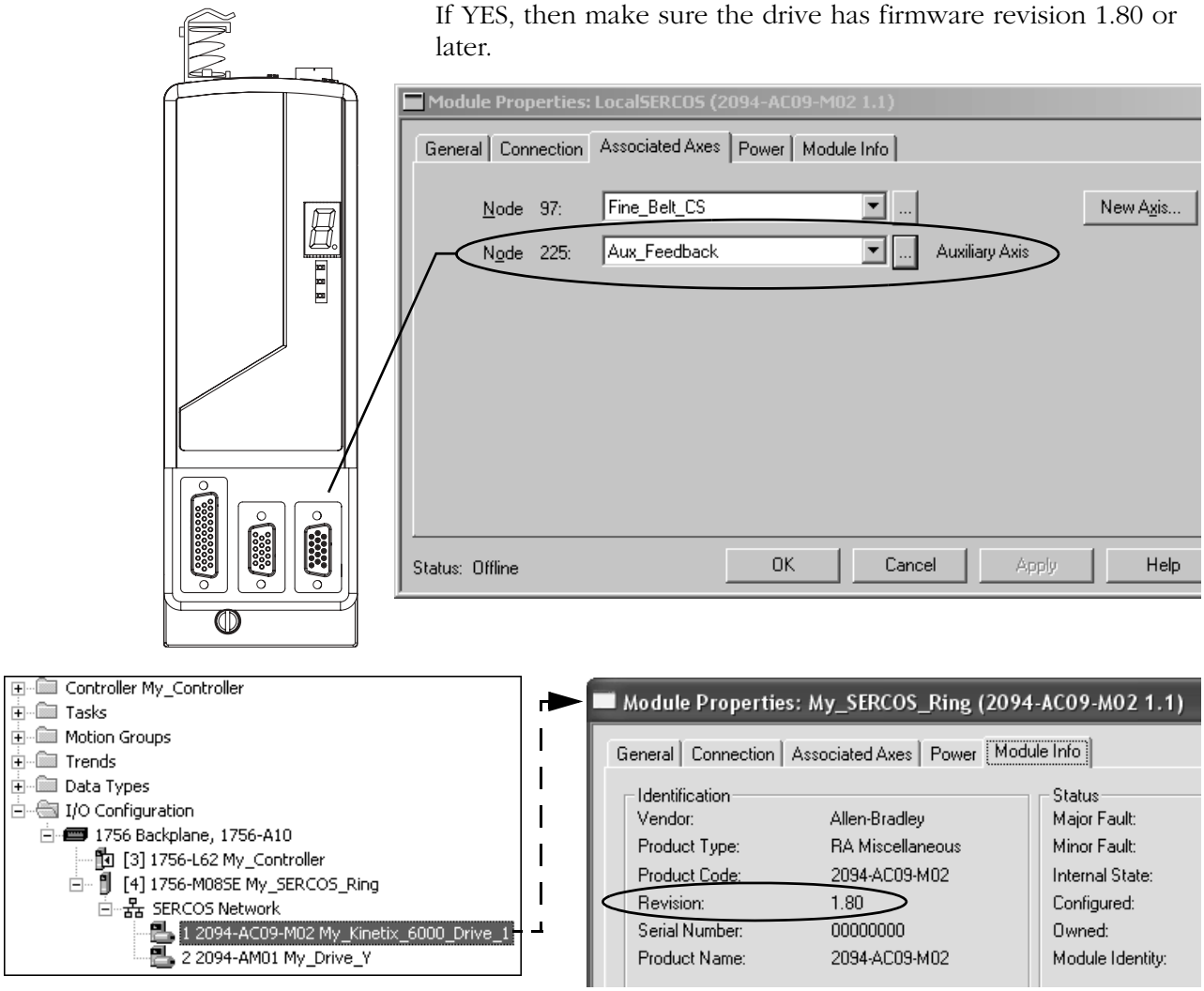
Associated Axes Tab (Kinetix 6000 Drives)

Use this tab to configure the selected 1756-M*xx*SE motion module by associating axis tags (of the type AXIS_SERVO_DRIVE) with nodes available on the module.

Figure 10.9 Module Properties - Associated Axes Tab

IMPORTANT Do you want to use the auxiliary feedback port of a Kinetix 6000 drive as a feedback-only axis?

If YES, then make sure the drive has firmware revision 1.80 or later.



Node

Displays the selected node of the Kinetix 6000 drive, as entered on the General tab. This field allows you to associate an AXIS_SERVO_DRIVE tag with the driver's node.

Note: This field is read-only while you are online.

Ellipsis (...)

Click on this button to access the Axis Properties dialog for the associated axis.

New Axis

Click on this button to access the New Tag dialog, with the scope, data type, and produced settings appropriate for a produced axis tag.

Power Tab - Kinetix Drive

Use this tab to select a bus regulator for your Kinetix 6000 drive.

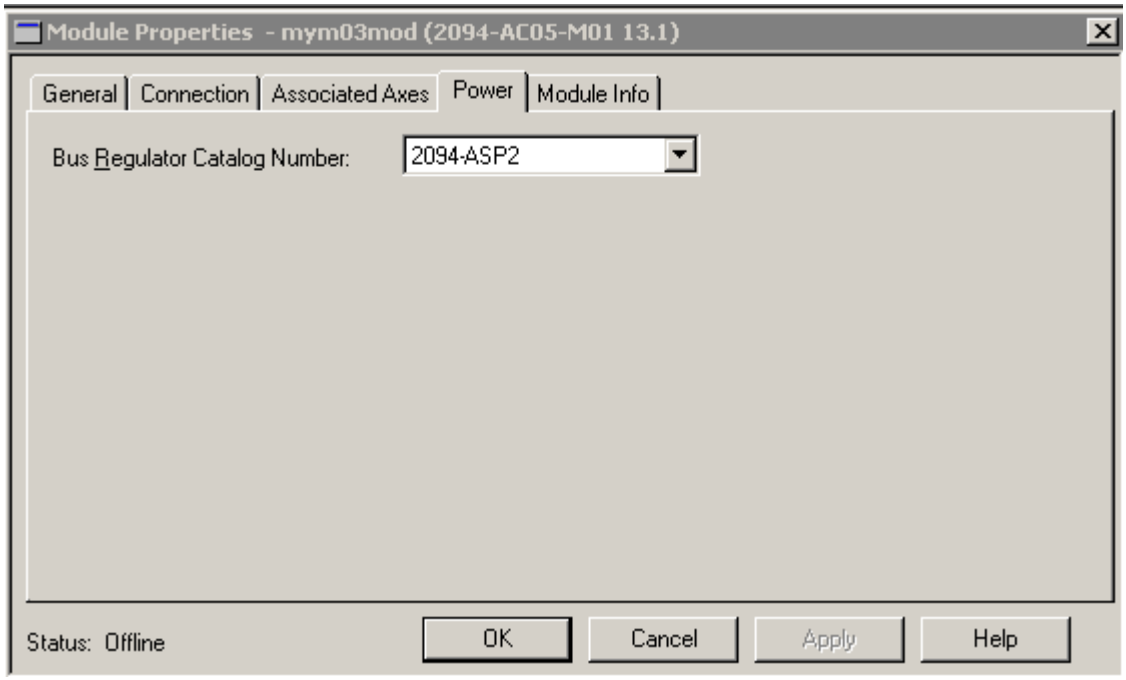


Figure 10.10 Module Properties - Power Tab

Bus Regulator Catalog Number

Select the catalog number that describes the bus regulator device used by the Kinetix 6000 drive module.

Module Info Tab

The Module Info Tab displays module and status information about the module. It also allows you to reset a module to its power-up state. The information on this tab is not displayed if you are either offline or currently creating a module

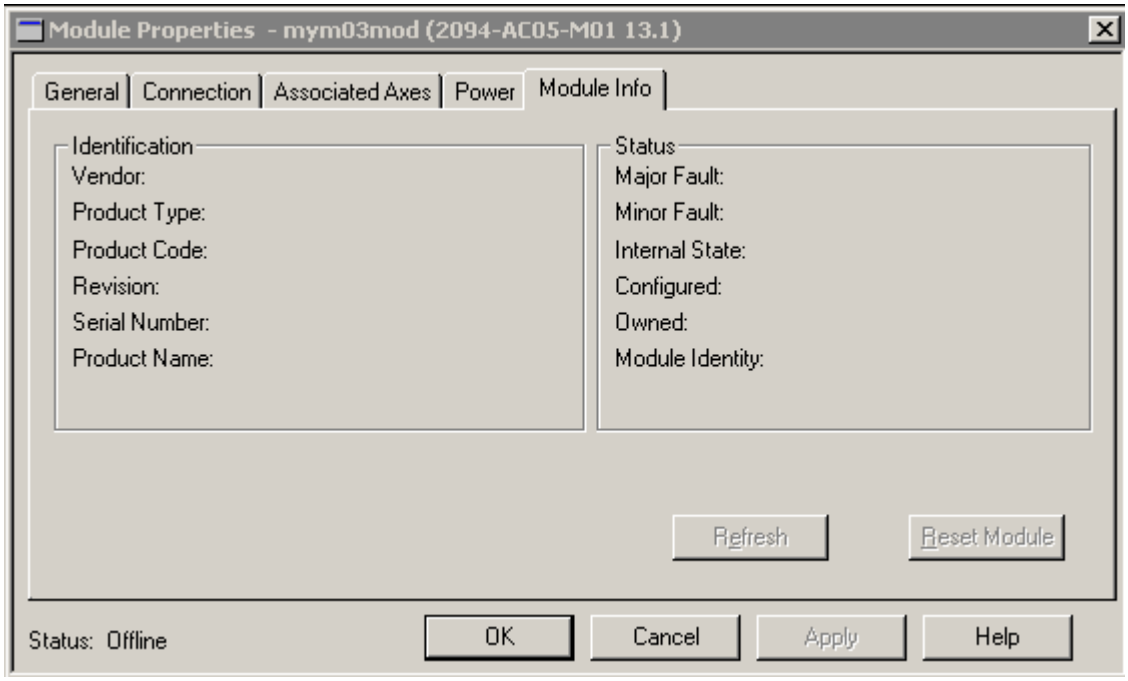


Figure 10.11 Module Properties - Module Info

TIP You can use this tab to determine the identity of the module.

The data on this tab comes directly from the module. If you selected a Listen-Only communication format when you created the module, this tab is not available.

- Refresh to display new data from the module.
- Reset Module to return the module to its power-up state by emulating the cycling of power. By doing this, you also clear all faults.

Identification

Displays the module's:

- Vendor
- Product Type
- Product Code

- Revision
- Serial Number
- Product Name

The name displayed in the Product Name field is read from the module. This name displays the series of the module. If the module is a 1756-L1 module, this field displays the catalog number of the memory expansion board (this selection applies to any controller catalog number even if additional memory cards are added.

Major/Minor Fault Status

If you are configuring a:	This field displays one of the following:
digital module	EEPROM fault Backplane fault None
analog module	Comm. Lost with owner Channel fault None
Any other module	None Unrecoverable Recoverable

Internal State Status

Displays the module's current operational state.

- Self-test
- Flash update
- Communication fault
- Unconnected
- Flash configuration bad
- Major Fault (please refer to "Major/Minor Fault Status" above)
- Run mode
- Program mode
- (16#xxxx) unknown

If you selected the wrong module from the module selection tab, this field displays a hexadecimal value. A textual description of this state is only given when the module identity you provide is a match with the actual module.

Configured

Displays a yes or no value indicating whether the module has been configured by an owner controller connected to it. Once a module

has been configured, it stays configured until the module is reset or power is cycled, even if the owner drops connection to the module. This information applies to I/O modules only and does not apply to adapters, scanners, bridges, or other communications modules.

Owned

Displays a yes or no value indicating whether an owner controller is currently connected to the module. This information applies to I/O modules only and does not apply to adapters, scanners, bridges, or other communications modules.

Module Identity

Displays:	If the physical module:
Match	agrees with what is specified on the General Tab order for the Match condition to exist, all of the following must agree: • Vendor • Module Type (the combination of Product Type and Product Code for a particular Vendor) • Major Revision
Mismatch	does not agree with what is specified on the General Tab

This field does not take into account the Electronic Keying or Minor Revision selections for the module that were specified on the General Tab.

Note: The Generic modules, such as the 1756-MODULE, always show a Mismatch because the configured Generic Key does not match any target device.

Reset Module

Click on this button to return a module to its power-up state by emulating the cycling of power.

Resetting a module causes all connections to or through the module to be closed, and this may result in loss of control.

Note: The following modules return an error if a reset is attempted:

- 1756-L1 ControlLogix5550 Programmable Controller
- 1336T AC Vector Drive
- 1395 Digital DC Drive

Note: A controller cannot be reset.

Refresh

Click on this button to refresh the tab with new data from the module.

If you are online in Program, Remote Program or Remote Run mode, and this controller is the owner controller, and you have changed the module's configuration in the software, then when you click the Apply or the OK button, the information is automatically sent to the controller. The controller tries to send the information to the module (if the module's connection is not inhibited). If you don't click Apply, your changes are not sent to the controller.

Configuring an 8720MC Drive

The Allen-Bradley 8720MC Drive System is a family of products designed to satisfy a wide range of machine tool spindle and power servo applications. For applications which do not require line regeneration, Allen-Bradley offers five 380 to 460 VAC input high performance digital drives with current outputs ranging from 21 to 48 amperes. For applications requiring line regeneration, the same five drives plus an additional 14 amp drive can be connected to a regenerative power supply via a 750V DC common bus interface. The complete family includes a set of twelve drive amplifiers capable of controlling a family of motors ranging in power from 5.5 to 93 kW.

The 8720MC Digital Servo Drive with fiber optic SERCOS interface simplifies the integration of the 8720MC with the ControlLogix architecture by providing single point drive commissioning through RSLogix 5000 software and reducing the control wiring to a single fiber optic cable.

You can initiate the configuration of an 8720MC drive module by either of two methods:

1. In the Controller Organizer, in the I/O Configuration branch, select a 1756-M*xx*SE motion module.

2. In the File menu, select New Component then Module.

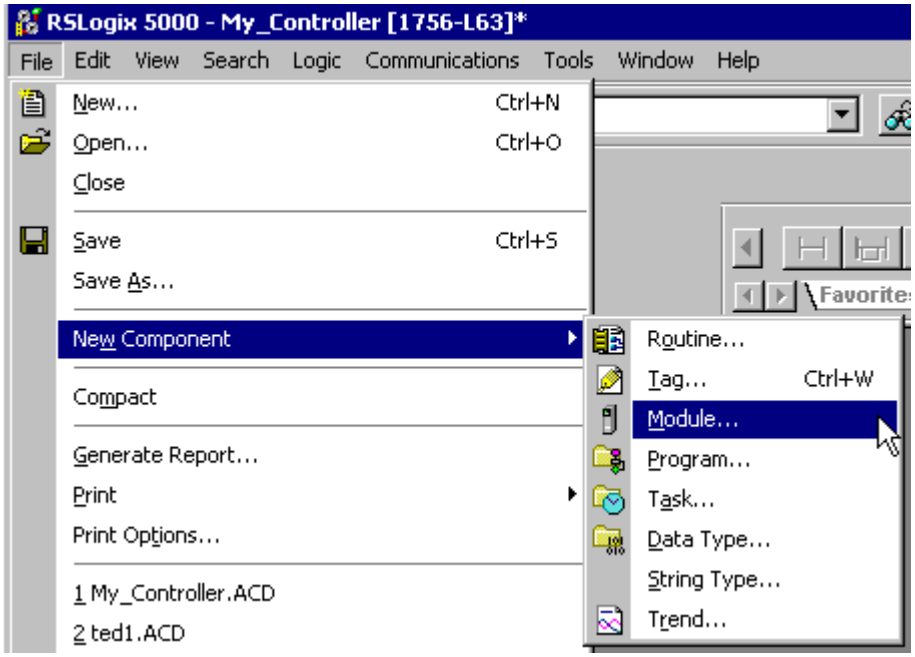


Figure 11.1 File Menu - New Component - Module

OR

1. Right click on the selected 1756-M08SE or 1756-M*xx*SE module in the I/O Configuration branch of the Controller Organizer.

2. Select New Module from the pop up menu.

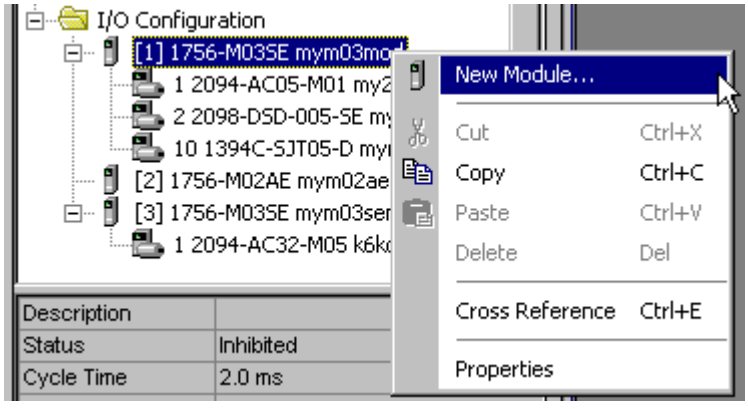


Figure 11.2 New Module Selection from Pop Up Menu

The Select Module Type dialog displays.

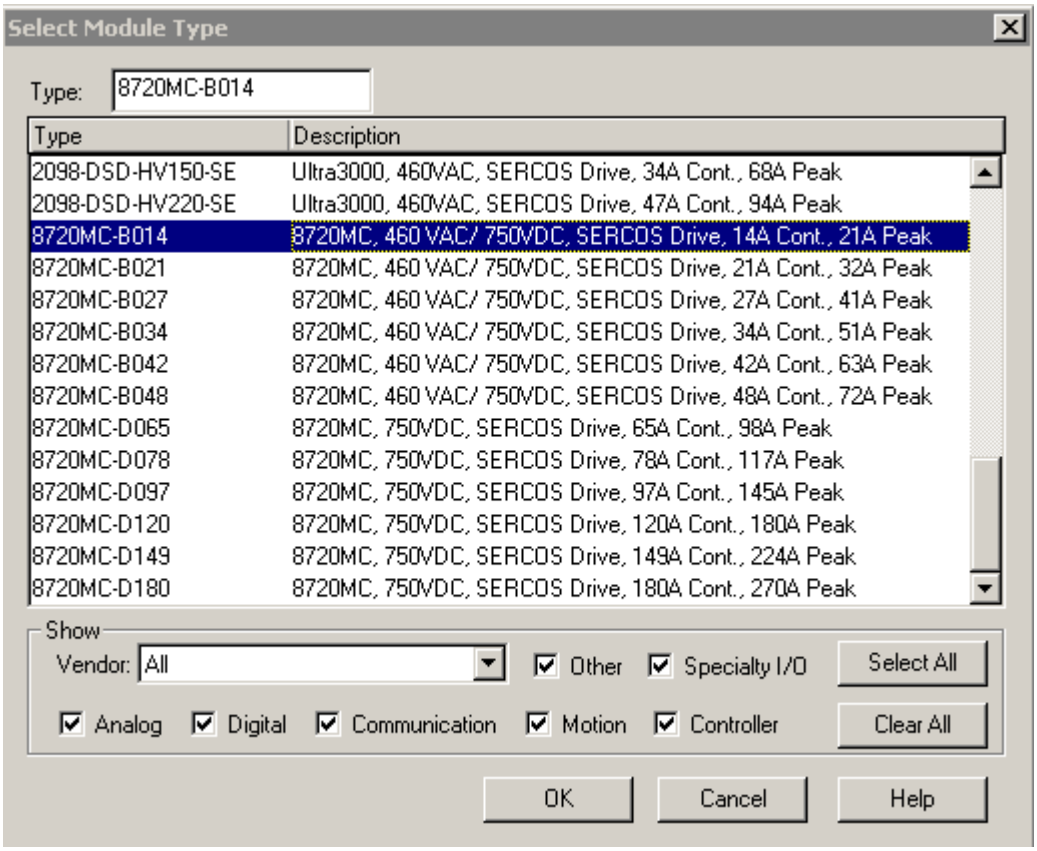


Figure 11.3 Select Module Type Window

3. In the Select Module Type dialog, select the desired drive module. The 8720MC drives begin with the 8720MC prefix.

4. Press the OK button to close the Select Module Type dialog. The 8720MC Drive Create Wizard Module Properties dialog opens.

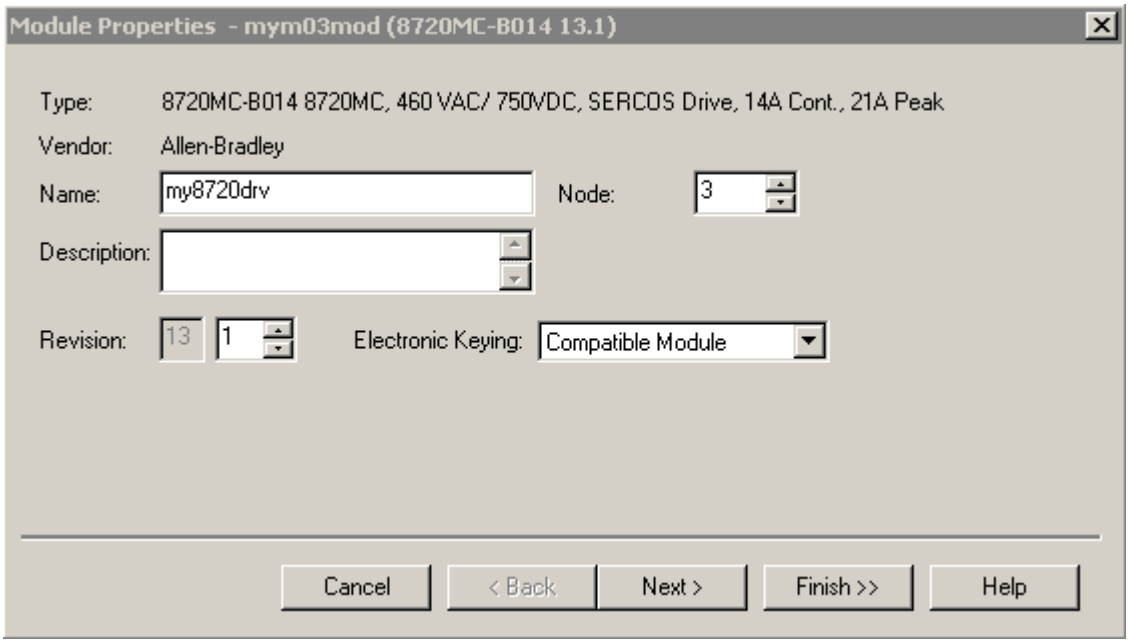


Figure 11.4 Module Properties Wizard Dialog - Naming the Drive

5. You must fill in a name for the drive; this is a required field. Fill in the responses for the other parameters as needed.

The following fields are displayed only if you are viewing this tab through the Create wizard.

Next> – Click this button to view the next Create wizard page.

<Back – Click this button to view the previous Create wizard page.

Finish>> – Click this button to close the Create wizard.

6. Click the Finish> button to place the new drive in the Controller Organizer.

7. After you click the Finish> button, a new drive module displays beneath the selected 1756-M*xx*SE motion module.

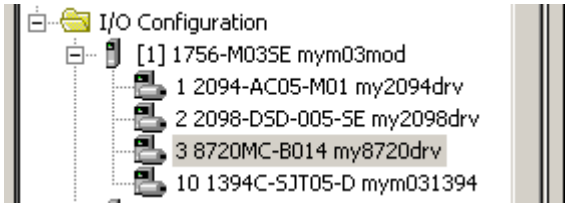


Figure 11.5 Controller Organizer - New 8720MC Drive

Editing the 8720MC Drive Properties

The Module Properties for any of the 8720MC drives can be edited by highlighting the drive to be edited, right click with the mouse and selecting Properties.

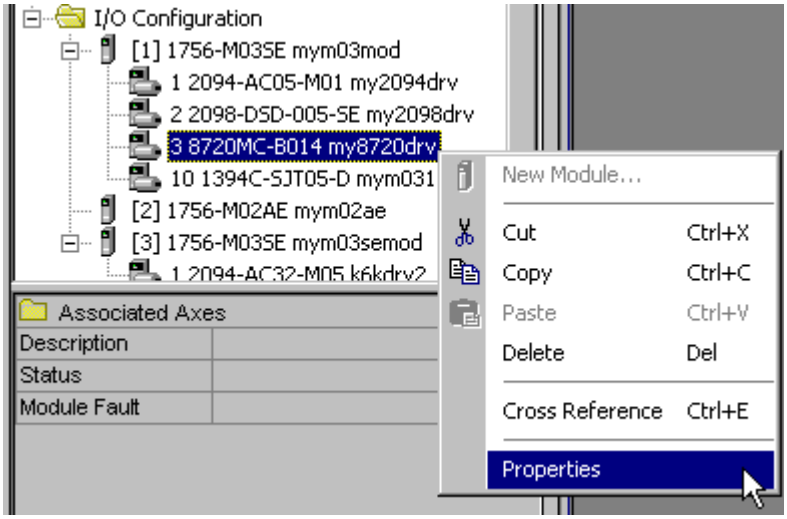


Figure 11.6 Accessing the Properties of the Drive

The Module Properties screen displays.

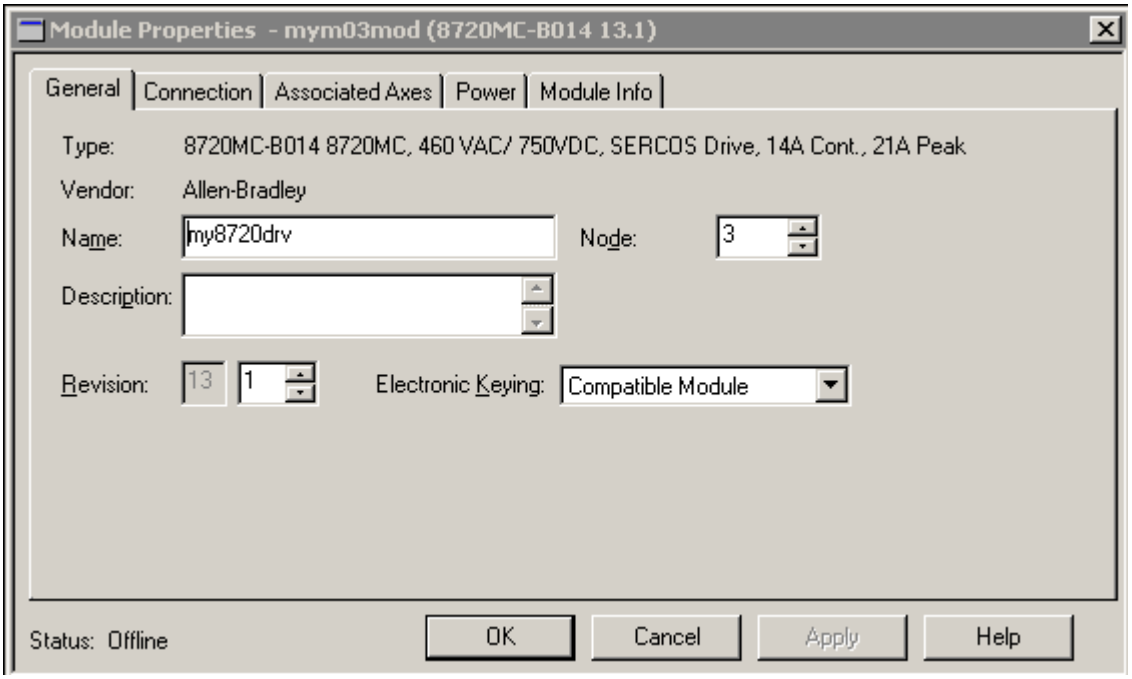


Figure 11.7 Module Properties - General Tab

General Tab The General Tab is where you edit the basic values for the drive.

Type

Displays the type and description of the module being created (read only).

Vendor

Displays the vendor of the module being created (read only).

Name

Enter the name of the module.

The name must be IEC 1131-3 compliant. This is a required field and must be completed, otherwise you receive an error message when you exit this tab. An error message is also displayed if a duplicate name is detected, or you enter an invalid character. If you exceed the maximum name length allowed by the software, the extra character(s) are ignored.

Description

Enter a description for the module here, up to 128 characters. You can use any printable character in this field. If you exceed the maximum length, the software ignores any extra character(s).

Node

Select the network node number of the module on the network. Valid values include those network nodes not in use between 1 to 99.

Revision

Select the minor revision number of your module.

The revision is divided into the major revision and minor revision. The major revision displayed statically is chosen on the Select Module Type dialog.

The major revision is used to indicate the revision of the interface to the module. The minor revision is used to indicate the firmware revision.

Electronic Keying

Select one of these keying options for your module during initial module configuration:

- Exact Match - all of the parameters described below must match or the inserted module will reject the connection.
- Compatible Modules – The following criteria must be met, or else the inserted module will reject the connection:
  - The Module Types, Catalog Number, and Major Revision must match.
  - The Minor Revision of the physical module must be equal to or greater than the one specified in the software.
- Disable Keying – does not employ keying at all.

ATTENTION

Changing the Electronic Keying selections may cause the connection to the module to be broken and may result in a loss of data.

Be extremely cautious when using this option; if used incorrectly, this option can lead to personal injury or death, property damage or economic loss.

When you insert a module into a slot in a ControlLogix chassis, RSLogix 5000 compares the following information for the inserted module to that of the configured slot:

- Vendor
- Product Type
- Catalog Number
- Major Revision
- Minor Revision

This feature prevents the inadvertent insertion of the wrong module in the wrong slot.

Status

Displays the status the controller has about the module:

This status:	Indicates:
Standby	A transient state that occurs when shutting down.
Faulted	The controller is unable to communicate with the module. When the status is Faulted, the Connection tab displays the fault.
Validating	A transient state that occurs before connecting to the module.
Connecting	A state that occurs while the connection(s) are being established to the module.

This status:	Indicates:
Running	The module is communicating and everything is working as expected.
Shutting Down	The connections are closing.
Inhibited	The connection to the module is inhibited.
Waiting	The connection to this module has not yet been made due to one of the following: • its parent has not yet made a connection to it • its parent is inhibited§ • its parent is faulted
Offline	You are not online.

Connection Tab Use this tab to define controller to module behavior.

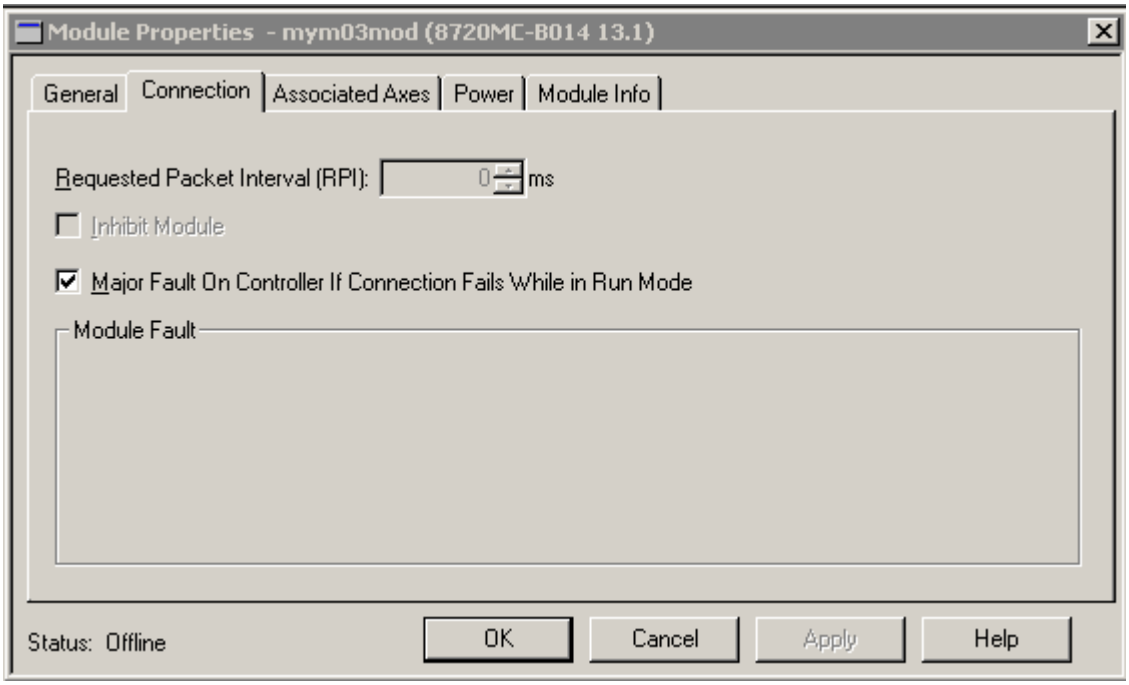


Figure 11.8 Module Properties - Connection Tab

On this tab, you can:

- Select a requested packet interval.
- Choose to inhibit the module.
- Configure the controller so loss of the connection to this module causes a major fault.

- View module faults.

TIP The data on this tab comes directly from the controller. This tab displays information about the condition of the connection between the module and the controller.

Requested Packet Interval

Does not apply to this setup. Field is greyed out.

> **Note:** This field is disabled for all motion modules (e.g., 1756-MO2AE, 1756-M08SE, 1756-M16SE modules and all 1394-, Ultra3000, Kinetix 6000, and 8720MC drives).

Inhibit Module

Check/Uncheck this box to inhibit/uninhibit your connection to the module. Inhibiting the module causes the connection to the module to be broken.

> **Note:** Inhibiting/uninhibiting connections applies mainly to direct connections, and not to the CNB module.

ATTENTION

Inhibiting the module causes the connection to the module to be broken and may result in loss of data.

When you check this box and go online, the icon representing this module in the controller organizer displays the Warning Icon.

If you are:	Check this checkbox to:
offline	put a place holder for a module you are configuring
online	stop communication to a module • If you inhibit the module while you are online and connected to the module, the connection to the module is nicely closed. The module's outputs go to the last configured Program mode state. • If you inhibit the module while online but a connection to the module has not been established (perhaps due to an error condition or fault), the module is inhibited. The module status information changes to indicate that the module is 'Inhibited' and not 'Faulted'. • If you uninhibit a module (clear the checkbox) while online, and no fault condition occurs, a connection is made to the module and the module is dynamically reconfigured (if you are the owner controller) with the configuration you have created for that module. If you are a listener (have chosen a "Listen Only" Communications Format), you can not re-configure the module. • If you uninhibit a module while online and a fault condition occurs, a connection is not made to the module.

Major Fault on Controller if Connection Fails checkbox

Check this box to configure the controller so that failure of the connection to this module causes a major fault on the controller if the connection for the module fails.

Module Fault

Displays the fault code returned from the controller (related to the module you are configuring) and the text detailing the Module Fault that has occurred.

The following are common categories for errors:

- **Connection Request Error** - The controller is attempting to make a connection to the module and has received an error. The connection was not made.
- **Service Request Error** - The controller is attempting to request a service from the module and has received an error. The service was not performed successfully.
- **Module Configuration Invalid** - The configuration in the module is invalid. (This error is commonly caused by the Electronic Key Passed fault).

- **Electronic Keying Mismatch** - Electronic Keying is enabled and some part of the keying information differs between the software and the module.

Associated Axes Tab (8720MC Drives)

Use this tab to configure the selected 1756-M*xx*SE motion module by associating axis tags (of the type AXIS_SERVO_DRIVE) with nodes available on the module.

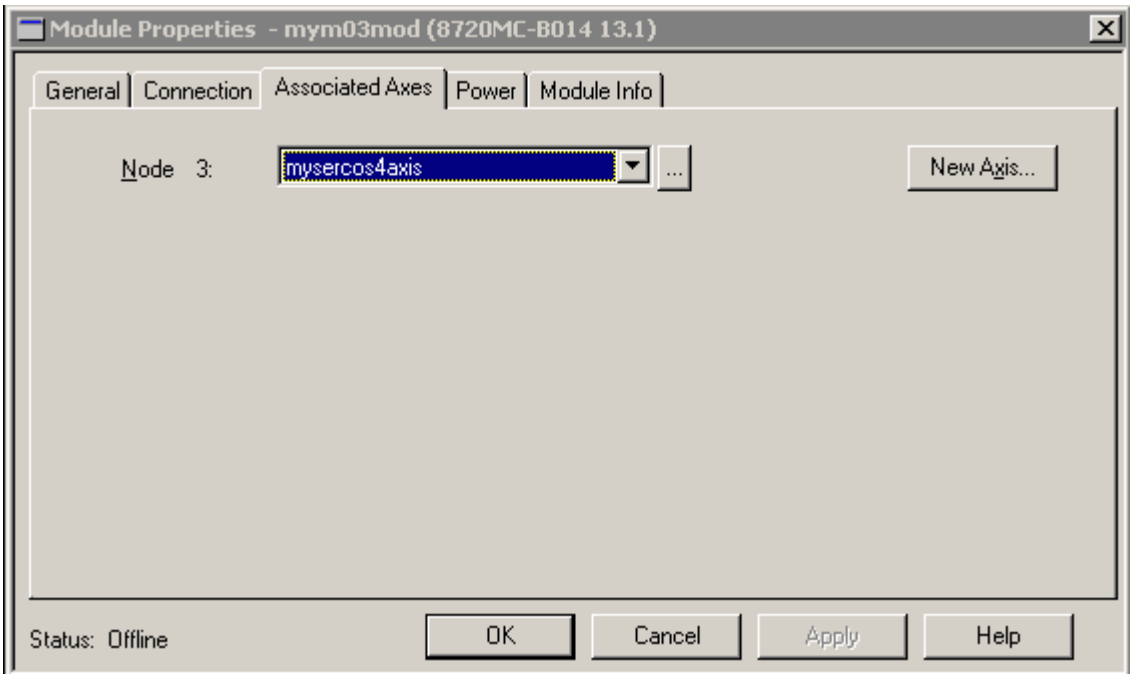


Figure 11.9 Module Properties - Associated Axes Tab

Node

Displays the selected node of the 8720MC drive, as selected on the General tab. This field allows you to associate an AXIS_SERVO_DRIVE tag with the driver's node.

Note: This field is read-only while you are online.

Ellipsis (...)

Click on this button to access the Axis Properties dialog for the associated axis.

New Axis

Click on this button to access the New Tag dialog, with the scope, data type, and produced settings appropriate for a produced axis tag.

See the chapter titled *Naming & Configuring Your Motion Axis* for the steps on how to configure a motion axis.

Power Tab - 8720MC Drive

Use this tab to select a bus regulator for your drive module.

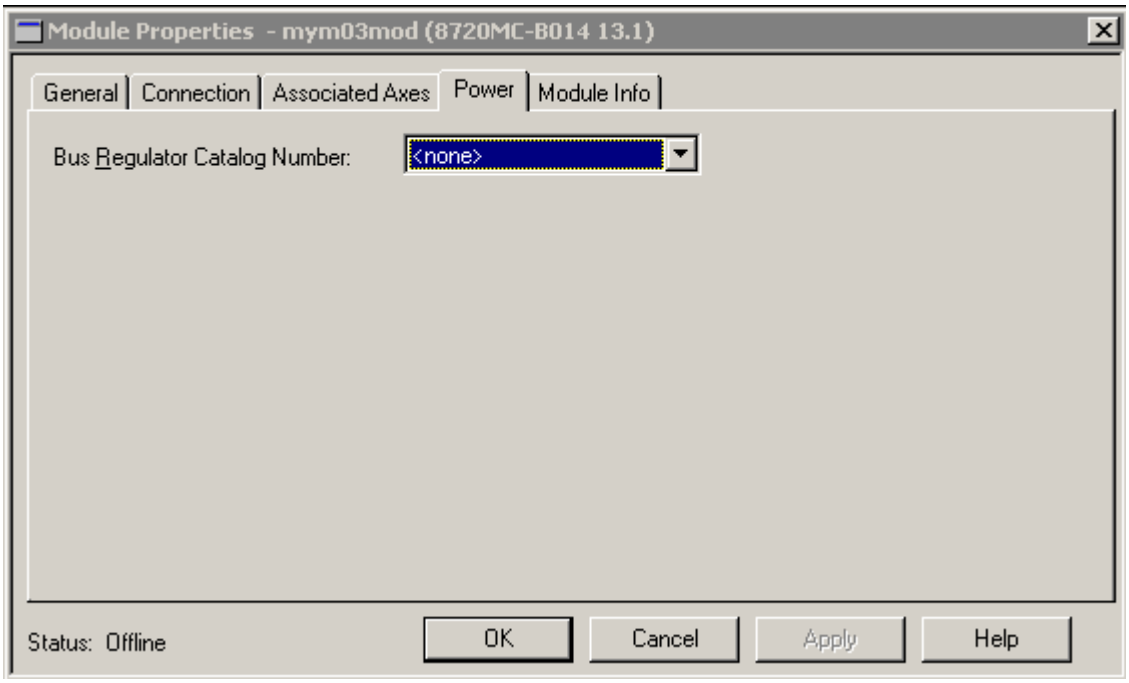


Figure 11.10 Module Properties - Power Tab

Note: The Power Tab does not apply to the 8720MC SERCOS drives.

Bus Regulator ID

Note: This parameter does not apply to the 8720MC SERCOS drives. The only available selection in the pull-down menu is <none>.

Module Info Tab

The Module Info Tab displays module and status information about the module. It also allows you to reset a module to its power-up state.

The information on this tab is not displayed if you are either offline or currently creating a module

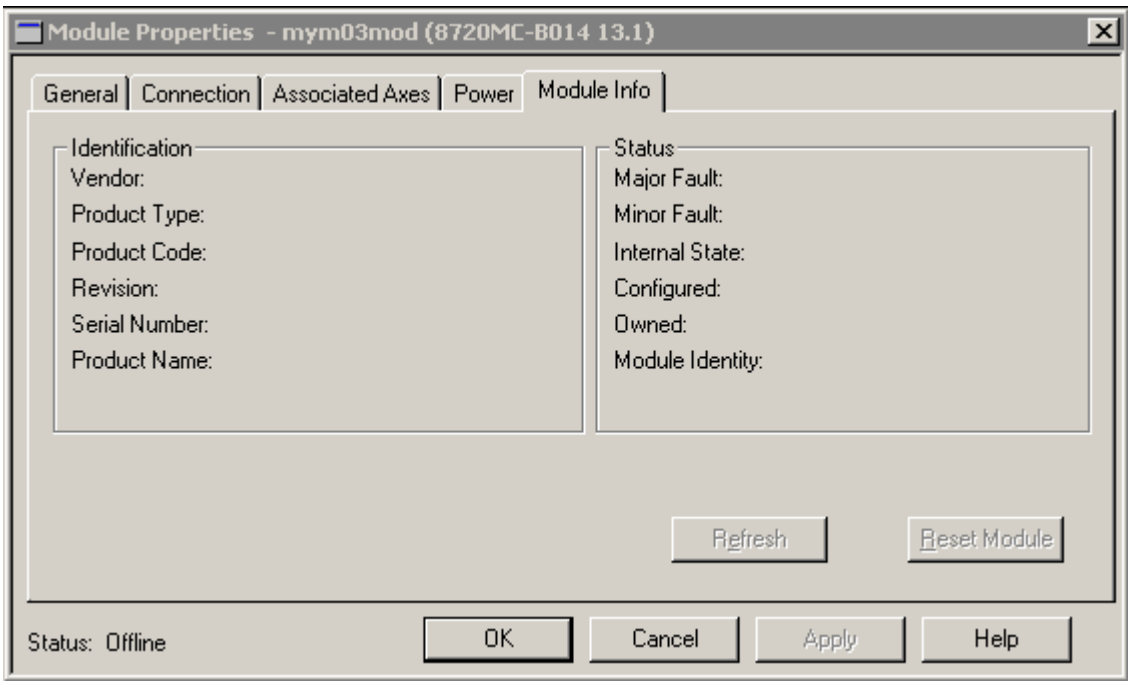


Figure 11.11 Module Properties - Module Info

TIP You can use this tab to determine the identity of the module.

The data on this tab comes directly from the module. If you selected a Listen-Only communication format when you created the module, this tab is not available.

- Refresh to display new data from the module.
- Reset Module to return the module to its power-up state by emulating the cycling of power. By doing this, you also clear all faults.

Identification

Displays the module's:

- Vendor
- Product Type
- Product Code
- Revision
- Serial Number

- Product Name

The name displayed in the Product Name field is read from the module. This name displays the series of the module.

Major/Minor Fault Status

If you are configuring a:	This field displays one of the following:
digital module	EEPROM fault Backplane fault None
analog module	Comm. Lost with owner Channel fault None
Any other module	None Unrecoverable Recoverable

Internal State Status

Displays the module's current operational state.

- Self-test
- Flash update
- Communication fault
- Unconnected
- Flash configuration bad
- Major Fault (please refer to "Major/Minor Fault Status" above)
- Run mode
- Program mode
- (16#xxxx) unknown

If you selected the wrong module from the module selection tab, this field displays a hexadecimal value. A textual description of this state is only given when the module identity you provide is a match with the actual module.

Configured

Displays a yes or no value indicating whether the module has been configured by an owner controller connected to it. Once a module has been configured, it stays configured until the module is reset or power is cycled, even if the owner drops connection to the module. This information applies to I/O modules only and does not apply to adapters, scanners, bridges, or other communications modules.

Owned

Displays a yes or no value indicating whether an owner controller is currently connected to the module. This information applies to I/O modules only and does not apply to adapters, scanners, bridges, or other communications modules.

Module Identity

Displays:	If the physical module:
Match	agrees with what is specified on the General Tab order for the Match condition to exist, all of the following must agree: • Vendor • Module Type (the combination of Product Type and Product Code for a particular Vendor) • Major Revision
Mismatch	does not agree with what is specified on the General Tab

This field does not take into account the Electronic Keying or Minor Revision selections for the module that were specified on the General Tab.

> **Note:** The Generic modules, such as the 1756-MODULE, always show a Mismatch because the configured Generic Key does not match any target device.

Reset Module

Click on this button to return a module to its power-up state by emulating the cycling of power.

Resetting a module causes all connections to or through the module to be closed, and this may result in loss of control.

The following modules return an error if a reset is attempted:

- 1756-L1 ControlLogix5550 Programmable Controller
- 1336T AC Vector Drive
- 1395 Digital DC Drive

> **Note:** A controller cannot be reset.

Refresh

Click on this button to refresh the tab with new data from the module.

If you are online in Program, Remote Program or Remote Run mode, and this controller is the owner controller, and you have changed the module's configuration in the software, then when you click the Apply or the OK button, the information is automatically sent to the controller. The controller tries to send the information to the module (if the module's connection is not inhibited). If you don't click Apply, your changes are not sent to the controller.

Motion Instructions

This chapter describes the motion instructions for RSLogix 5000 programming software.

The motion instructions for the RSLogix 5000 programming software consist of seven main categories:

- Motion State instructions – to control or change the operating state of an axis.
- Motion Move instructions – to control all aspects of axis position.
- Motion Group instructions – to control a group of axes.
- Motion Event instructions – control the arming and disarming of special event checking functions.
- Motion Configuration instructions – to tune an axis and to run diagnostic tests for the system.
- Multi-Axis Coordinated Motion instructions – to control all aspects of coordinated motion.
- Motion Direct Commands

For more information about	Refer to
Motion instructions	The *Logix5000 Controller Motion Instruction Set Reference Manual,* publication 1756-RM007
Types of motion instruction timing	Appendix E - *Instruction Timing*

Motion State Instructions

Motion state instructions directly control or change the operating state of an axis.

The motion state instructions are:

Instruction	Abbreviation	Description
Motion Servo On	MSO	Enables the servo drive and activates the axis servo loop

Motion Servo Off	MSF	Disables the servo drive and deactivates the axis servo loop
Motion Axis Shutdown	MASD	Forces an axis into the shutdown operating state Once the axis is in the shutdown state, the controller will block any instructions that initiate axis motion.
Motion Axis Shutdown Reset	MASR	Changes an axis from an existing shutdown operating state to an axis ready operating state If all of the axes of a servo module are removed from the shutdown state as a result of this instruction, the OK relay contacts for the module close.
Motion Direct Drive On	MDO	Enables the servo drive and sets the servo output voltage of an axis
Motion Direct Drive Off	MDF	Disables the servo drive and sets the servo output voltage to the output offset voltage
Motion Axis Fault Reset	MAFR	Clears all motion faults

For more information about motion state instructions, refer to the *Motion State Instructions* chapter of the *Logix Controller Motion Instruction Set Reference Manual*, publication 1756-RM007.

For more information about instruction timing, refer to Appendix E - *Instruction Timing*.

Motion Move Instructions

Motion move instructions control all aspects of axis position.

The motion move instructions are:

Instruction	Abbreviation	Description
Motion Axis Stop	MAS	Initiates a controlled stop of any motion process on an axis
Motion Axis Home	MAH	Homes an axis
Motion Axis Jog	MAJ	Initiates a jog motion profile for an axis
Motion Axis Move	MAM	Initiates a move profile for an axis
Motion Axis Gear	MAG	Enables electronic gearing between two axes
Motion Change Dynamics	MCD	Changes the speed, acceleration rate, or deceleration rate of a move profile or jog profile in progress
Motion Redefine Position	MRP	Changes the command or actual position of an axis

Motion Calculate Cam Profile	MCCP	Calculates a Cam Profile based on an array of cam points.
Motion Axis Position Cam	MAPC	Performs electronic camming between any two axes designated in the specified Cam Profile.
Motion Axis Time Cam	MATC	Performs electronic camming as a function of time designated in the specified Cam Profile.
Motion Calculate Slave Values	MCSV	Calculates the slave value, slope value, and derivative of the slope for a given cam profile and master value.

For more information about motion state instructions, refer to the *Motion Move Instructions* chapter of *Logix Controller Motion Instruction Set Reference Manual*, publication 1756-RM007.

For more information about instruction timing, refer to Appendix E - *Instruction Timing*.

Motion Group Instructions

Motion group instructions initiate action on all axes in a group.

The motion group instructions are:

Instruction	Abbreviation	Description
Motion Group Stop	MGS	Initiates a stop of motion on a group of axes
Motion Group Shutdown	MGSD	Forces all the axes in a group into the shutdown operating state
Motion Group Shutdown Reset	MGSR	Transitions a group of axes from the shutdown operating state to the axis ready operating state
Motion Group Strobe Position	MGSP	Latches the current command and actual positions of all the axes in a group

For more information about motion state instructions, refer to the *Motion Group Instructions* chapter of *Logix Controller Motion Instruction Set Reference Manual*, publication 1756-RM007.

For more information about instruction timing, refer to Appendix E - *Instruction Timing*.

Motion Event Instructions

Motion event instructions control the arming and disarming of special event checking functions, such as registration and watch position.

The motion event instructions are:

Instruction	Abbreviation	Description
Motion Arm Watch Position	MAW	Arms watch-position event checking for an axis
Motion Disarm Watch Position	MDW	Disarms watch-position event checking for an axis
Motion Arm Registration	MAR	Arms servo module registration event checking for an axis
Motion Disarm Registration	MDR	Disarms servo module registration event checking for an axis
Motion Arm Output Cam	MAOC	Arms an Output Cam for a particular Axis and Output as determined by the operands for the instruction.
Motion Disarm Output Cam	MDOC	Disarms either one or all Output Cams connected to a specified axis depending on the selection in the Disarm Type operand.

For more information about motion state instructions, refer to the *Motion Event Instructions* chapter of *Logix Controller Motion Instruction Set Reference Manual*, publication 1756-RM007.

For more information about instruction timing, refer to Appendix E - *Instruction Timing*.

Motion Configuration Instructions

Motion configuration instructions allow you to tune an axis and to run diagnostic tests for your control system. These tests include:

- A motor/encoder hookup test
- An encoder hookup test
- A marker test

The motion configuration instructions are:

Instruction	Abbreviation	Description
Motion Apply Axis Tuning	MAAT	Computes a complete set of servo gains and dynamic limits based on a previously executed MRAT instruction The MAAT instruction also updates the servo module with the new gain parameters.
Motion Run Axis Tuning	MRAT	Commands the servo module to run a tuning motion profile for an axis

Motion Apply Hookup Diagnostic	MAHD	Applies the results of a previously executed MRHD instruction The MAHD instruction generates a new set of encoder and servo polarities based on the observed direction of motion during the MRHD instruction.
Motion Run Hookup Diagnostic	MRHD	Commands the servo module to run one of three diagnostic tests on an axis

For more information about motion state instructions, refer to the *Motion Configuration Instructions* chapter of *Logix Controller Motion Instruction Set Reference Manual*, publication 1756-RM007.

For more information about instruction timing, refer to Appendix E - *Instruction Timing*.

Coordinated Motion Instructions

Coordinated Motion instructions control all aspects of multi-axis coordinated motion.

The coordinated motion instructions are:

Instruction	Abbreviation	Description
Motion Coordinated Linear Move	MCLM	Initiates a single or multi-dimensional linear coordinated move for the specified axes within a Cartesian coordinate system.
Motion Coordinated Circular Move	MCCM	Initiates a two- or three-dimensional circular coordinated move for the specified axes within a Cartesian coordinate system.
Motion Coordinated Change Dynamics	MCCD	Initiates a change in path dynamics for coordinate motion active on the specified coordinate system.
Motion Coordinated Stop	MCS	Initiates a controlled stop of the specified coordinate motion profile taking place on the designated coordinate system.
Motion Coordinated Shutdown	MCSD	Initiates a controlled shutdown of all of the axes of the coordinate system.
Motion Coordinated Shutdown Reset	MCSR	Initiates a reset of all of the axes of the specified coordinate system from the shutdown state to the axis ready state and clears the axis faults.

Motion Direct Commands

The Motion Direct Commands feature lets you issue motion commands while you are online without having to write or execute an application program. Motion Direct Commands are particularly useful

when you are commissioning or debugging a motion application. During commissioning, you can configure an axis and monitor the behavior using Trends in the Controller Organizer. Use of Motion Direct Commands can “fine-tune” the system with or without load to optimize its performance. When in the testing and or debugging cycle, you can issue Motion Direct Commands to establish or reestablish conditions such as Home. Often during initial development or enhancement to mature applications you need to test the system in small manageable areas. These areas can include - Home to establish initial conditions, Incrementally Move to a physical position, and monitor system dynamics under specific conditions.

Accessing Direct Commands

The Motion Direct Command dialog can be accessed from the Tools pull-down of the Main Menu, by right clicking on the Group in the Controller Organizer, and by right clicking on an Axis in the Controller Organizer. The point of entry determines the look of the opening dialog and the default values that are set.

From the Main Menu

You can access the Motion Direct Commands dialog directly from the Tool pull-down of the Main Menu.

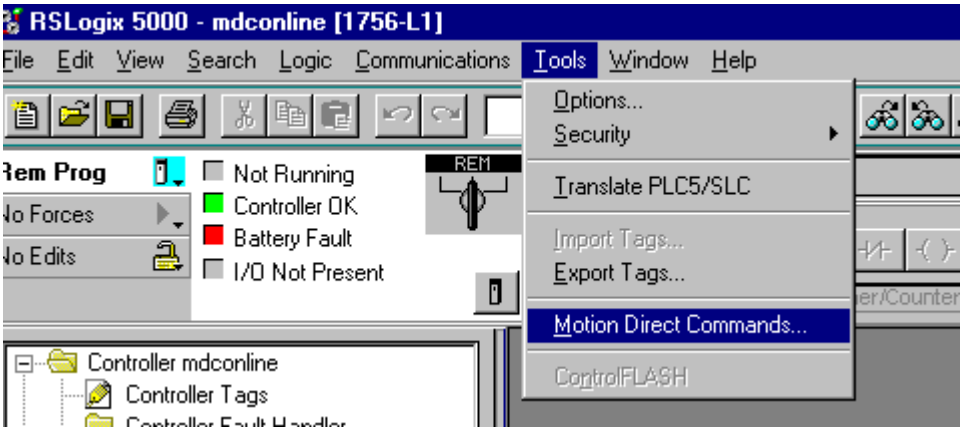


Figure 12.1 Main Menu | Tools Pull-down | Motion Direct Commands

When you access the Motion Direct Commands dialog from the Tools pull-down, it defaults to the MSO command and the Axis field is defaulted to a question mark (?).

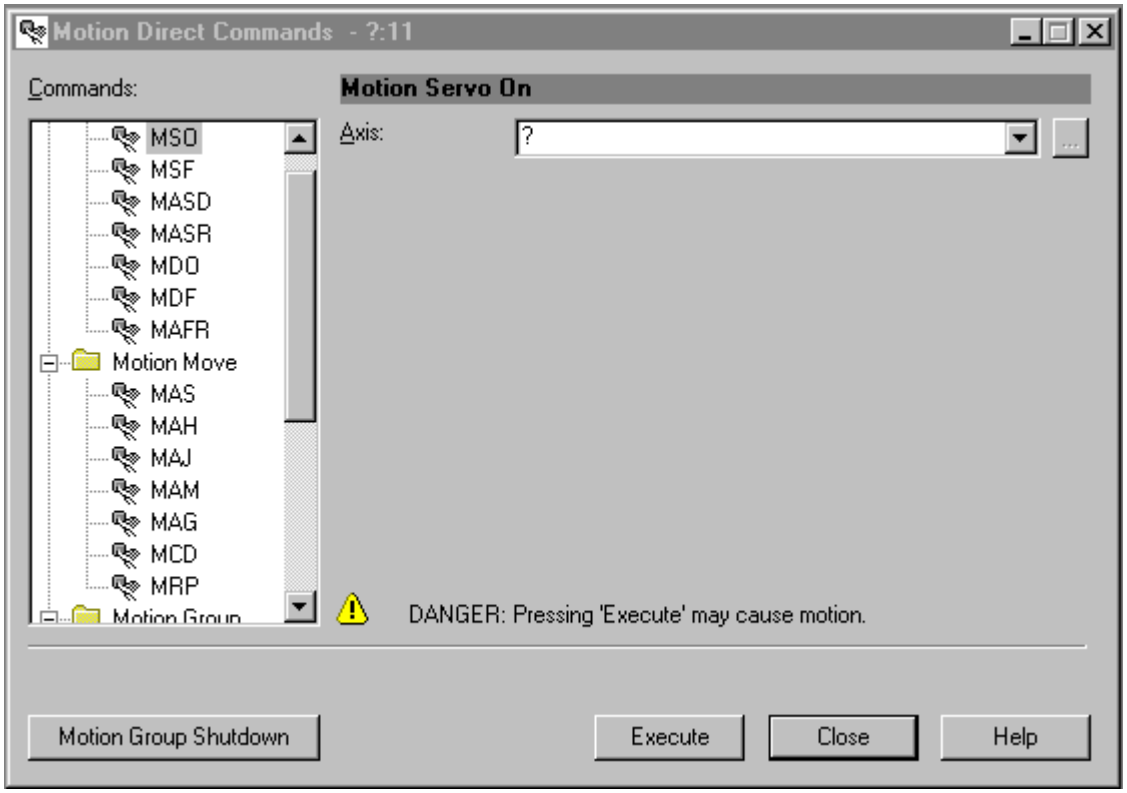


Figure 12.2 Motion Direct Command Dialog from Tool Menu

From Group in the Controller Organizer

You can access the Motion Direct Commands by right clicking on the Group in the Controller Organizer. This is the recommended way when you want to invoke a Motion Group Instruction.

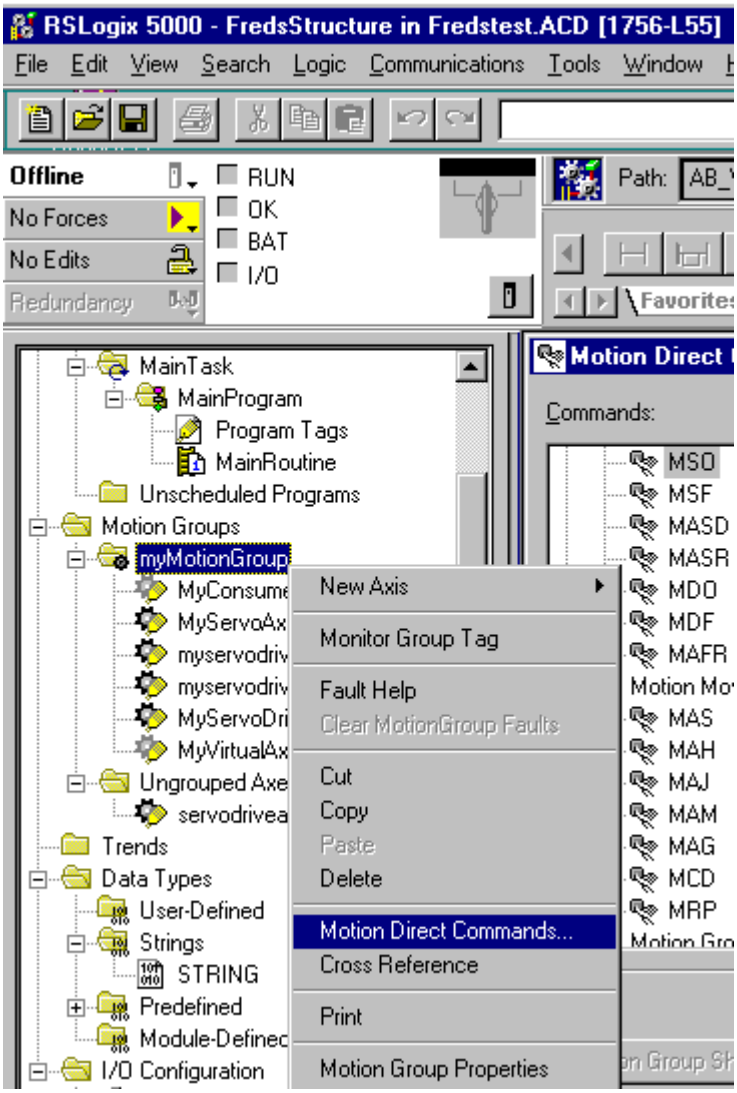


Figure 12.3 Controller Organizer | Group | Motion Direct Commands

When the Motion Direct Commands dialog is accessed from the Motion Group in the Controller Organizer, the Motion Group field

defaults to the group you right clicked on and the MGS command is the default selection.

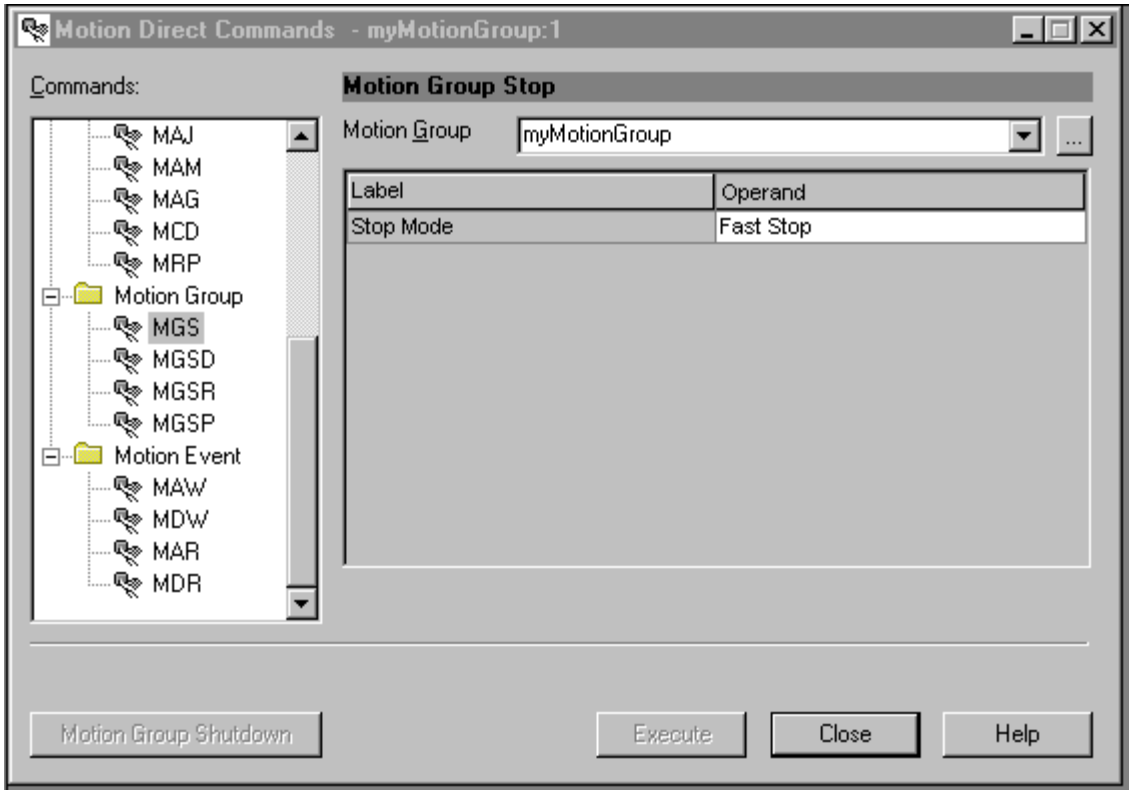


Figure 12.4 Motion Direct Command Dialog from Motion Group

From Axis in the Controller Organizer

You can access the Motion Direct Commands by right clicking on an Axis in the Controller Organizer. This is the recommended way when you want to invoke a Motion Instruction for an axis.

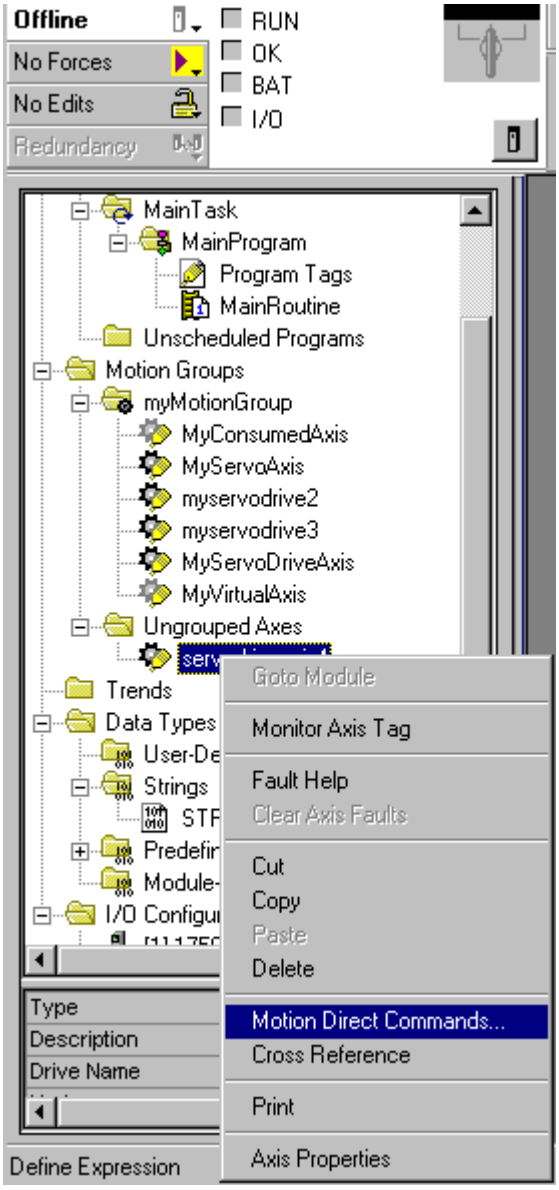


Figure 12.5 Controller Organizer | Axis | Motion Direct Commands

When the Motion Direct Commands dialog is accessed from an Axis in the Controller Organizer, the Axis field defaults to the axis you right clicked on and the MSO command is the default selection.

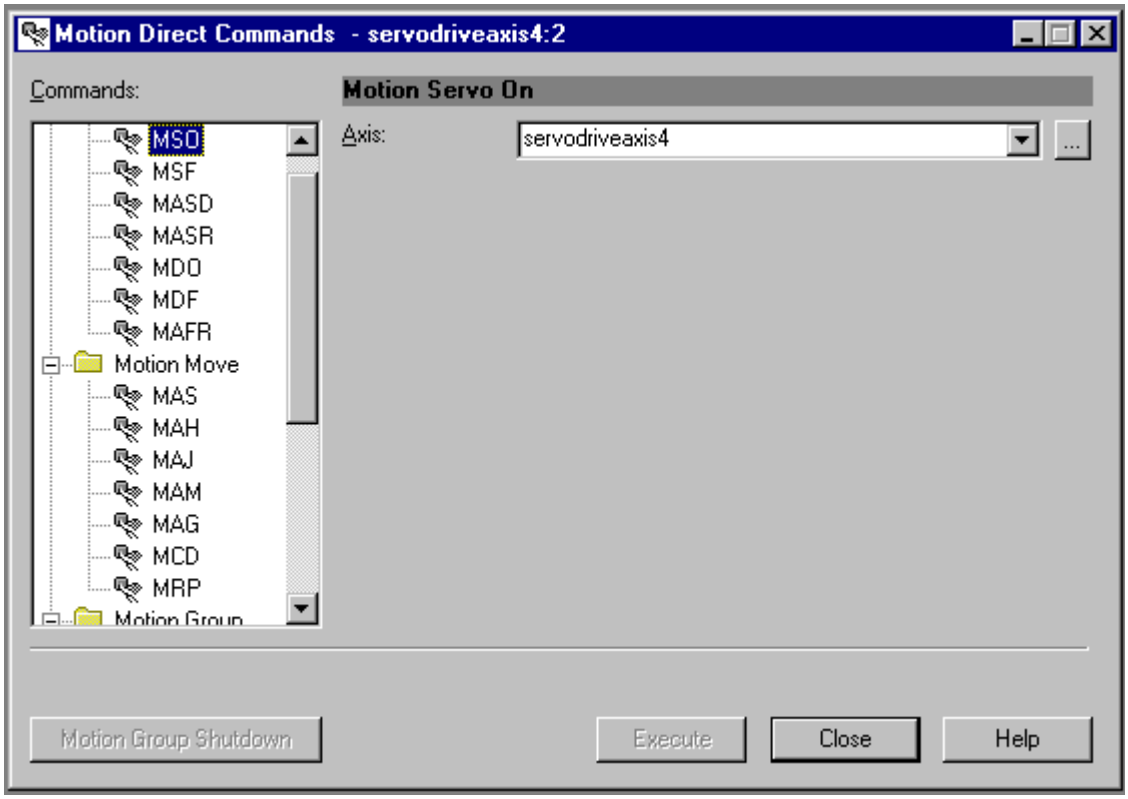


Figure 12.6 Motion Direct Command Dialog from Axis

Supported Commands

The list of instructions supported by the Motion Direct Commands feature include:

Motion State

Command	Description
MSO	Enable the servo drive and activate the axis servo loop.
MSF	Disable the servo drive and deactivate the axis servo loop.
MASD	Force an axis into the shutdown operating state. Once the axis is in the shutdown operating state, the controller blocks any instructions that initiate axis motion.
MASR	Change an axis from an existing shutdown operating state to an axis ready operating state. If all of the axes of a servo module are removed from the shutdown state as a result of this instruction, the OK relay contacts for the module close.

Command	Description
MDO	Enable the servo drive and set the servo output voltage of an axis.
MDF	Disable the servo drive and set the servo output voltage to the output offset voltage.
MAFR	Clear all motion faults for an axis.

Motion Move

Command	Description
MAS	Initiate a controlled stop of any motion process on an axis.
MAH	Home an axis.
MAJ	Initiate a jog motion profile for an axis.
MAM	Initiate a move profile for an axis.
MAG	Provide electronic gearing between any two axes
MCD	Change the speed, acceleration rate, or deceleration rate of a move profile or a jog profile in progress.
MRP	Change the command or actual position of an axis.

Motion Group

Command	Description
MGS	Initiate a stop of motion on a group of axes.
MGSD	Force all axes in a group into the shutdown operating state.
MGSR	Transition a group of axes from the shutdown operating state to the axis ready operating state.
MGSP	Latch the current command and actual position of all axes in a group.

Motion Event

Command	Description
MAW	Arm watch-position event checking for an axis.
MDW	Disarm watch-position event checking for an axis.
MAR	Arm servo-module registration-event checking for an axis.
MDR	Disarm servo-module registration-event checking for an axis.

For more information about the use and operation of Motion Direct Commands see the *Logix Controller Motion Instruction Set Reference Manual*, publication number 1756-RM007.

Motion Direct Command Dialog

The Motion Direct Commands dialog is similar in position and behavior to other dialogs in RSLogix5000. The dialog can be accessed when the system is either off-line or on-line.

Motion Direct Command Dialog On-line

In order to execute a Motion Direct Command, you must be on-line. The on-line dialog has the Motion Group Shutdown and Execute buttons active. If you click on either of these, action is taken immediately.

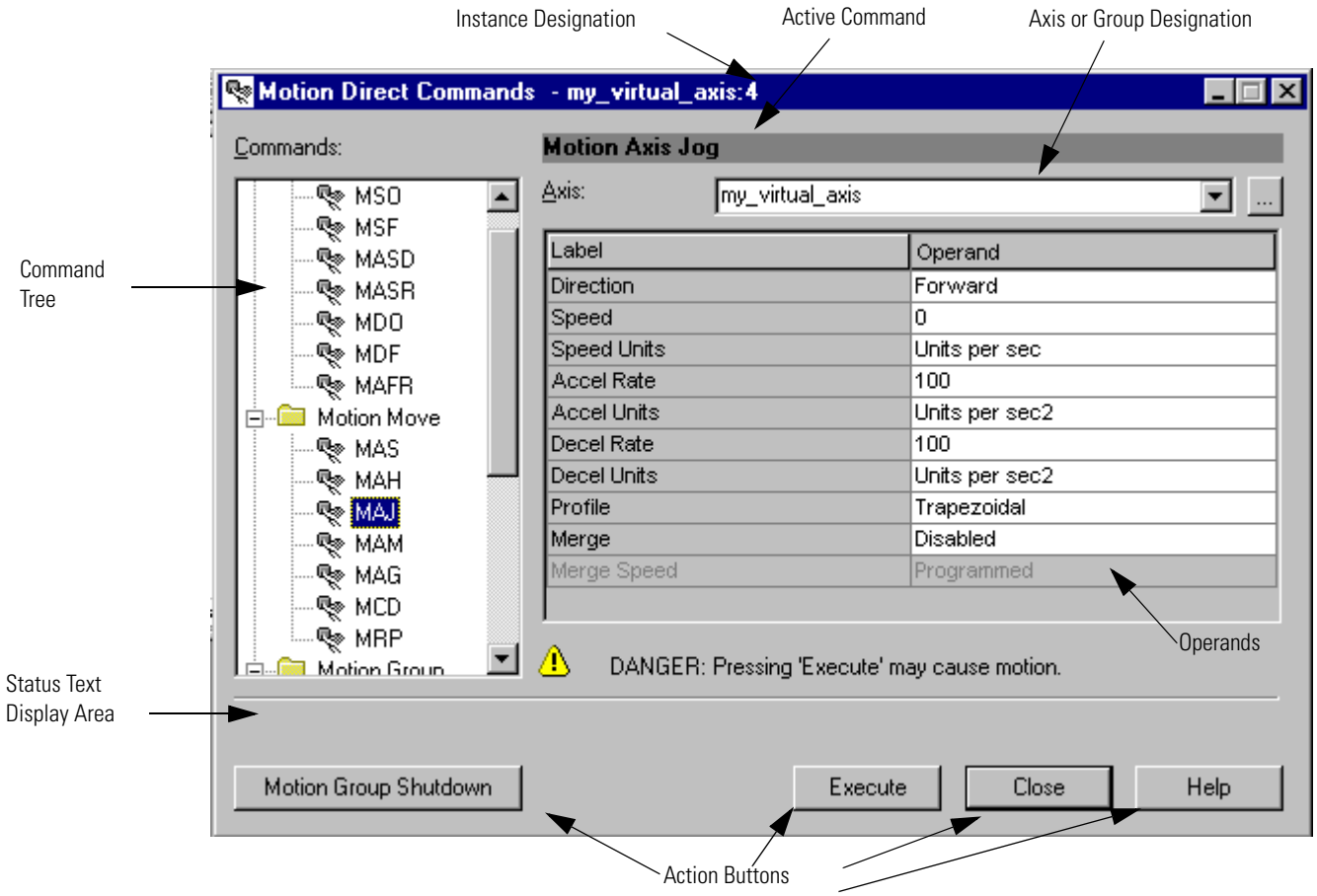


Figure 12.7 Motion Direct Command Dialog (on-line)

When the Motion Direct Command dialog is opened, focus is given to the Command Tree. In the Command list, you can either type the mnemonic and the list advances to the closest match or you can scroll

down the list to select a command. Click on the desired command and its dialog displays.

At the top of the dialog, in the title bar, there is a number at the end of the axis or group that the command is being applied upon. This is the Instance reference number. This number increases by one every time a command is accessed for that axis or group. The number is cleared when you execute RSLogix.

Located at the bottom of the dialog are the following buttons: Motion Group Shutdown, Execute, Close, and Help.

Motion Group Shutdown Button

The Motion Group Shutdown button is located to the left of the screen to avoid accidental invoking of this command when you really want to execute the command accessed from the Command tree. Clicking on this button causes the Motion Group Shutdown instruction to execute. If you click on the Motion Group Shutdown button and it is successfully executed, a Result message is displayed in the results window below the dialog. Since the use of this button is an abrupt means of stopping motion, an additional message is displayed in the error text field. The message "MOTION GROUP SHUTDOWN executed!" is displayed with the intention of giving greater awareness of the execution of this command. If the command fails then an error is indicated as per normal operation. (See Error Conditions later in this chapter.)

There is space above the Motion Group Shutdown button and below the line where status text is displayed when a command is executed.

Execute Button

Clicking the Execute button verifies the operands and initiates the current Motion Direct Command. Verification and error messages display as the

Close Button

To end a Motion Direct Command session, click on the Close button. The data is not saved and the command is not executed. It acts the same as a Cancel button.

Help Button

Click on the Help button to access the on-line Help.

Motion Object Attributes

Introduction

The Motion Object Attributes are included in this manual to provide you with a greater understanding of how the system works. Your familiarity with these attributes allows you to take greater advantage of the flexibility inherent in the RSLogix software. The Axis Object Interface Attributes comprise all the axis object attributes that are used by RSLogix 5000 to support the interface to the axis object including configuration attributes used in customizing many of the configuration screens and motion instructions that operate on the axis object.

Motion Object Interface Attributes

The Axis Object Interface Attributes comprise all the axis object attributes that are used by external software (e.g. RSLogix5000) to support the interface to the axis object including configuration attributes used in customizing many of the configuration screens and motion instructions that operate on the axis object

Object Support Attributes

The following attributes are used by software to establish the interfaces and structure of the motion axis object instance.

Axis Structure Address

The Axis Structure Address is used to return the actual physical address in memory where the axis instance is located.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Axis Structure Address	DINT	Absolute Address of Axis Structure

Axis Instance

The Axis Instance attribute is used to return the instance number of an axis. Major fault records generated for an axis major fault contains only the instance of the offending axis. This attribute would then typically be used by a user to determine if this was the offending axis; i.e. if the instance number matches..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Axis Instance	DINT	Instance Number assigned to Axis

Group Instance The Assigned Group Instance attribute is used to determine what motion group object instance this axis is assigned to..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Assigned Group Instance	DINT	Instance Number of Group assigned to Axis

Map Instance The axis is associated to a specific motion compatible module by specifying the instance of the map entry representing the module.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Map Instance	DINT	I/O Map Instance Number. This is 0 for virtual and consumed Data Types.

Module Channel The axis is associated to a specific channel on a motion compatible module by specifying the Module Channel attribute.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Module Channel	SINT	Zero based channel number of the module. 0xff, indicates unassigned.

The axis is associated to a specific channel on a motion compatible module by specifying the Module Channel attribute.

Module Class Code The ASA class code of the object in the motion module which is supporting motion; e.g., 0xAF is the ASA object ID of the “Servo Module Axis Object” residing in the 1756-M02AE module.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Module Class Code	DINT	ASA Object class code of the motion engine in the module; e.g., 0xAF for the M02AE module.

C2C Map Instance When the Axis Data Type attribute is specified to be ‘Consumed’ then this axis is associated to the consumed data by specifying both the C2C Map Instance and the C2C Connection Instance. For all other Axis Data Types if this axis is to be produced then this attribute is set to 1

(one) to indicate that the connection is off of the local controller's map instance.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	C2C Map Instance	SINT	Producer/Consumed axis's associated C2C map instance

C2C Connection Instance

When Axis Data Type is specified to be 'Consumed' then this axis is associated to the consumed data by specifying both the C2C Map Instance and the C2C Connection Instance. This attribute is the connection instance under the C2C map instance, which provides the axis data being sent to it from another axis via a C2C connection.

For all other Axis Data Types if this axis is to be produced then this attribute is set to the connection instance under the local controller's map instance (1) that is used to send the remote axis data via the C2C connection.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	C2C Connection Instance	SINT	Producer/Consumed axis's associated C2C connection instance in reference to the C2C map instance

Memory Use

RSLogix 5000 software uses this attribute to create axis instances in I/O memory for axes that are either to be produced or consumed. The Memory Use attribute can only be set as part of an axis create service and is used to control which controller memory the object instance is created in.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Memory Use	INT	Controller memory space where instance exists. 105 (0x69) = I/O space 106 (0x6a) = Data Table space

Memory Usage

The Memory Use attribute can be used to determine the amount of memory the created instance consumes in bytes.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Memory Usage	DINT	Amount of memory consumed for this instance (in bytes)

Axis Data Type The Axis Data Type attribute and is used to determine which data template, memory format, and set of attributes are created and applicable for this axis instance. This attribute can only be set as part of an axis create service.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Axis Data Type	SINT	Associated motion axis tag data type: 0 = Feedback 1 = Consumed 2 = Virtual 3 = Generic 4 = Servo 5 = Servo Drive.

Feedback

A feedback-only axis associated with feedback-only modules like PLS II and CFE, supporting quadrature encoder, resolver, HiperFace, etc.

Consumed

A consumed axis which consumes axis motion data produced by a motion axis on another Logix processor.

Virtual

A virtual axis having full motion planner operation but not associated with any physical device.

Generic

An axis with full motion planner functionality but no integrated configuration support; associated with devices such as DriveLogix, 1756-DM.

Servo

An axis with full motion planner functionality and integrated configuration support; associated with modules closing a servo loop and sending an analog command to an external drive; i.e., 1756-M02AE, 1756-HYD02, and 1756-M02AS modules.

Servo Drive

An axis with full motion planner functionality and integrated configuration support; associated with digital drive interface modules sending a digital command to the external drive; i.e., 1756-M03SE, 1756-M08SE, and 17556-M16SE (SERCOS interface).

Axis Configuration State

The Axis Configuration State attribute is used for debugging purposes to indicate where in the axis configuration state-machine this axis presently is. Even consumed and virtual axes will utilize this attribute.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Axis Configuration State	SINT	State of the axis configuration state machine

Axis State

The Axis State attribute indicates what the operating state is of the axis. Possible states are axis-ready, direct drive control, servo control, axis faulted & axis shutdown. Reference the Ac Motion Instructions Software Functional Specification for further detail on these states.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Axis State	SINT	Axis State: 0 = Axis Ready 1 = Direct Drive Control 2 = Servo Control 3 = Axis Faulted 4 = Axis Shutdown

Watch Event Task Instance

The Watch Event Task Instance attribute indicates which user Task is triggered when a watch event occurs. The user Task is triggered at the same time that the Process Complete bit is set for the instruction that armed the watch event. This attribute attributes is set through internal communication from the user Task object to the Axis object when the Task trigger attribute is set to an select the Watch Event Task Instance attribute of the Axis. This attribute should not be set directly by an external device. This attribute is available to be read externally (Get attributes List) for diagnostic information.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Watch Event Task Instance	DINT	User Event Task that is triggered to execute when a Watch event occurs. An instance value of 0 indicates that no event task has been configured to be triggered by the Watch Event.

Registration 1 Event Task Instance

The Registration 1 Event Task Instance attribute indicates which user Task is triggered when a Registration 1 event occurs. The user Task is triggered at the same time that the Process Complete bit is set for the instruction that armed the watch event. This attribute attributes is set through internal communication from the user Task object to the Axis object when the Task trigger attribute is set to an select the Registration 1 Event Task Instance attribute of the Axis. This attribute

should not be set directly by an external device. This attribute is available to be read externally (Get attributes List) for diagnostic information.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Registration 1 Event Task Instance	DINT	User Event Task that is triggered to execute when a Registration 1 event occurs. An instance value of 0 indicates that no event task has been configured to be triggered by the Registration 1 Event.

Registration 2 Event Task Instance

The Registration 2 Event Task Instance attribute indicates which user Task is triggered when a Registration 2 event occurs. The user Task is triggered at the same time that the Process Complete bit is set for the instruction that armed the watch event. This attribute attributes is set through internal communication from the user Task object to the Axis object when the Task trigger attribute is set to an select the Registration 2 Event Task Instance attribute of the Axis. This attribute should not be set directly by an external device. This attribute is available to be read externally (Get attributes List) for diagnostic information.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Registration 2 Event Task Instance	DINT	User Event Task that is triggered to execute when a Registration 2 event occurs. An instance value of 0 indicates that no event task has been configured to be triggered by the Registration 2 Event.

Home Event Task Instance

The Home Event Task Instance attribute indicates which user Task is triggered when a home event occurs. The user Task is triggered at the same time that the Process Complete bit is set for the instruction that armed the home event. This attribute attributes is set through internal communication from the user Task object to the Axis object when the Task trigger attribute is set to an select the Home Event Task Instance attribute of the Axis. This attribute should not be set directly by an external device. This attribute is available to be read externally (Get attributes List) for diagnostic information.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Home Event Task Instance	DINT	User Event Task that is triggered to execute when a Home event occurs. An instance value of 0 indicates that no event task has been configured to be triggered by the Home Event.

Motion Object Status Attributes

The Motion Status Attributes are comprised of all Motion Axis Object variables that are “read-only”, i.e. attributes that you can get from the axis object, but not set.

Motion Status Attributes

The Motion Status Attributes associated with the Axis Object provide access to the current and historical position velocity, and acceleration information of the axis. These values may be used as part of the user program to implement sophisticated real time computations associated with motion control applications. A list of all Motion Status Attributes is shown in the tables below. For all of the Motion Status attributes to return a meaningful value, the ‘Conversion Constant’ Axis Configuration Attribute must be established. Attributes having velocity units (Position Units / Sec) must have a valid coarse update period which is established through association with a fully configured Motion Group Object.

All Motion Status attributes support Direct Tag Access via RSLogix5000 software. Thus, a Motion Status attribute may be directly referenced in a program as <axis tag name>.<motion status tag name>. An example of this might be FeedAxis.ActualPosition.

To avoid the unnecessary processor effort associated with real-time conversion of certain Motion Status tags that are not of interest to the user, it is necessary to explicitly activate real-time update of these attributes via the Auto Tag Update attribute of the associated motion group. A subset of the Motion Status attributes must have the Auto Tag Update attribute enabled or the tag value is forced to zero. The following Motion Status attributes are affected:

- Actual Position
- Actual Velocity
- Actual Acceleration
- Master Offset
- Command Position
- Command Velocity
- Command Acceleration
- Average Velocity.

Actual Position

Actual Position is the current absolute position of an axis, in the configured Position Units of that axis, as read from the feedback transducer. Note, however, that this value is based on data reported to the ControlLogix Processor as part of an ongoing synchronous data transfer process which results in a delay of one coarse update period.

Thus, the Actual Position value that is obtained is the actual position of the axis one coarse update period ago.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Actual Position	REAL	Position Units

Command Position

Command Position is the desired or commanded position of a physical axis, in the configured Position Units of that axis, as generated by the controller in response to any previous motion Position Control instruction. Command Position data is transferred by the ControlLogix Processor to a physical axis as part of an ongoing synchronous data transfer process which results in a delay of one coarse update period. Thus, the Command Position value that is obtained is the command position that is acted upon by the physical servo axis one coarse update period from now.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Command Position	REAL	Position Units

The figure below shows the relationship between Actual Position, Command Position, and Position Error for an axis with an active servo loop. Actual Position is the current position of the axis as measured by the feedback device (e.g., encoder). Position error is the difference between the Command and Actual Positions of the servo loop, and is used to drive the motor to make the actual position equal to the command position.

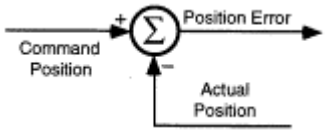


Figure 13.1 Position Error

Command position is useful when performing motion calculations and incremental moves based on the current position of the axis while the axis is moving. Using command position rather than actual position avoids the introduction of cumulative errors due to the position error of the axis at the time the calculation is performed.

Strobe Position

Strobe Actual Position, and Strobe Command Position are used to simultaneously store a snap-shot of the actual, command position and master offset position of an axis when the MGSP (Motion Group Strobe Position) instruction is executed. The values are stored in the configured Position Units of the axis. Refer to the AC Motion

Instruction Specification for a detailed description of the MGSP instruction.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Strobe Actual Position	REAL	Position Units
GSV	Strobe Command Position	REAL	Position Units

Since the MGSP instruction simultaneously stores the actual and command positions for all axes in the specified group of axes, the resultant Strobe Actual Position and Strobe Command Position values for different axes can be used to perform real time calculations. For example, the Strobe Actual Positions can be compared between two axis to provide a form of "slip compensation" in web handling applications.

Start Position

Whenever a new motion planner instruction starts for an axis (for example, using a MAM instruction), the value of the axis command position and actual position is stored at the precise instant the motion begins. These values are stored as the Start Command Position and Start Actual Position respectively in the configured Position Units of the axis.

Internal Access Rule	Attribute Name	ASA Data Type	Semantics of Values
GSV	Start Actual Position	REAL	Position Units
GSV	Start Command Position	REAL	Position Units

Start Positions are useful to correct for any motion occurring between the *detection* of an event and the action *initiated* by the event. For instance, in coil winding applications, Start Command Positions can be used in an expression to compensate for overshooting the end of the bobbin before the gearing direction is reversed. If you know the position of the coil when the gearing direction was *supposed* to change, and the position at which it *actually* changed (the Start Command Position), you can calculate the amount of overshoot, and use it to correct the position of the wire guide relative to the bobbin.

Average Velocity

Average Velocity is the current speed of an axis in the configured Position Units per second of the axis. Unlike the Actual Velocity attribute value, it is calculated by averaging the actual velocity of the axis over the configured Average Velocity Timebase for that axis.

Average velocity is a signed value with the sign indicating the direction the axis is currently moving.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Average Velocity	REAL	Position Units / Sec

The resolution of the Average Velocity variable is determined by the current value of the Averaged Velocity Timebase parameter, and the configured Conversion Constant (feedback counts per Position Unit) for the axis. The greater the Average Velocity Timebase value, the better the speed resolution, but the slower the response to changes in speed.

The Average Velocity resolution in Position Units per second may be calculated using the equation below.

$$\frac{1}{\text{Averaged Velocity Timebase [Seconds]} \times K \left[\frac{\text{Feedback Counts}}{\text{Position Unit}}\right]}$$

For example, on an axis with position units of inches and a conversion constant (K) of 20000, an averaged velocity time-base of 0.25 seconds results in an average velocity resolution of:

$$\frac{1}{0.25 \times 20000} = 0.0002 \frac{\text{Inches}}{\text{Second}} = 0.012 \frac{\text{Inches}}{\text{Minute}}$$

Note that the minimum Average Velocity Timebase value is Coarse Update period defined by the associated Motion Group Object. See the *Motion Configuration Attribute* section of this document for more information on setting the Averaged Velocity Timebase and the Conversion Constant parameters.

Actual Velocity

Actual Velocity is the current instantaneously measured speed of an axis, in the configured axis Position Units per second. It is calculated as the current increment to the actual position per coarse update interval. Actual Velocity is a signed value—the sign (+ or -) depends on which direction the axis is currently moving.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Actual Velocity	REAL	Position Units / Sec

Actual Velocity is a signed floating-point value. Its resolution does not depend on the Averaged Velocity Timebase, but rather on the

conversion constant of the axis and the fact that the internal resolution limit on actual velocity is 1 feedback counts per coarse update.

Command Velocity

Command Velocity is the commanded speed of an axis, in the configured axis Position Units per second, as generated by any previous motion instructions. It is calculated as the current increment to the command position per coarse update interval. Command Velocity is a signed value—the sign (+ or -) depends on which direction the axis is being commanded to move.

Internal Access Rule	Attribute Name	ASA Data Type	Semantics of Values
GSV	Command Velocity	REAL	Position Units / Sec

Command Velocity is a signed floating-point value. Its resolution does not depend on the Averaged Velocity Timebase, but rather on the conversion constant of the axis and the fact that the internal resolution limit on command velocity is 0.00001 feedback counts per coarse update.

Actual Acceleration

Actual Acceleration is the current instantaneously measured acceleration of an axis, in the configured axis Position Units per second per second. It is calculated as the current increment to the actual velocity per coarse update interval. Actual Acceleration is a signed value — the sign (+ or -) depends on which direction the axis is currently accelerating.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Actual Acceleration	REAL	Position Units / Sec^2

Actual Acceleration is a signed floating-point value. Its resolution does not depend on the Averaged Velocity Timebase, but rather on the conversion constant of the axis and the fact that the internal resolution limit on actual velocity is 1 feedback counts per coarse update period per coarse update period.

Command Acceleration

Command Acceleration is the commanded speed of an axis, in the configured axis Position Units per second per second, as generated by any previous motion instructions. It is calculated as the current increment to the command velocity per coarse update interval.

Command Acceleration is a signed value—the sign (+ or -) depends on which direction the axis is being commanded to move.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Command Acceleration	REAL	Position Units / Sec^2

Command Acceleration is a signed floating-point value. Its resolution does not depend on the Averaged Velocity Timebase, but rather on the conversion constant of the axis and the fact that the internal resolution limit on command velocity is 0.00001 feedback counts per coarse update period per coarse update period.

Watch Position

Watch Position is the current set-point position of an axis, in the configured axis Position Units, as set up in the last, most recently executed, MAW (Motion Arm Watch) instruction for that axis. Refer to the AC Motion Instruction Specification for a detailed description of the MAW instruction.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Command Acceleration	REAL	Position Units / Sec^2

Registration Position

Two registration position attributes are provided to independently store axis position associated with two different registration input events. The Registration Position value is the absolute position of a physical or virtual axis (in the position units of that axis) at the occurrence of the most recent registration event for that axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Registration 1 Position	REAL	Position Units
GSV	Registration 2 Position	REAL	Position Units

The figure below shows how the registration position is latched by the registration input when a registration event occurs. The latching mechanism can be implemented in the controller software (soft registration) or, for greater accuracy, in physical hardware (hard registration).

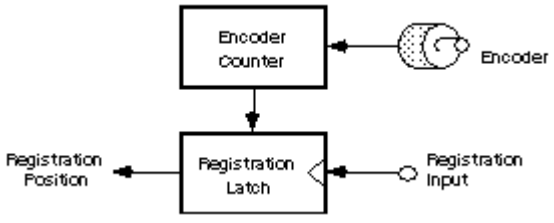


Figure 13.2 Registration Position

The Registration Latch mechanism is controlled two Event Control instructions, MAR (Motion Arm Registration) and MDR (Motion Disarm Registration). Refer to the AC Motion Instruction Specification for a detailed description of these instructions.

The accuracy of the registration position value, saved as a result of a registration event, is a function of the delay in recognizing the specified transition (typically 1 µsec for hardware registration) and the speed of the axis during this time. The uncertainty in the registration position is the distance traveled by the axis during this interval as shown by the equation below:

$$\text{Uncertainty} = \text{Axis Speed}\left[\frac{\text{Position Units}}{\text{Second}}\right] \times \text{Delay}$$

Use the formula given above to calculate the maximum registration position error for the expected axis speed. Alternatively, you can calculate the maximum axis speed for a specified registration accuracy by re-arranging this formula as shown below:

$$\text{Maximum Speed}\left[\frac{\text{Position Units}}{\text{Second}}\right] = \frac{\text{Desired Accuracy [Position Units]}}{\text{Delay}}$$

Registration Time The two Registration Time values contain the lower 32-bits of CST time at which their respective registration events occurred. Units for this attribute are in microseconds.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Registration 1 Time	DINT	Lower 32 bits of CST time
GSV	Registration 2 Time	DINT	Lower 32 bits of CST time

Interpolation Time Interpolated Time is the 32-bit CST time used to calculate the interpolated positions. When this attribute is updated with a valid CST value, the Interpolated Actual Position and Interpolated Command Position values are automatically calculated.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Interpolation Time	DINT	CST time to interpolate to

Interpolated Actual Position

Interpolated Actual Position is the interpolation of the actual position, based on past axis trajectory history, at the time specified by the "Interpolated Time" attribute.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Interpolated Actual Position	REAL	Position Units

Interpolated Command Position

Interpolated Command Position is the interpolation of the commanded position, based on past axis trajectory history, at the time specified by the "Interpolated Time" attribute.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Interpolated Command Position	REAL	Position Units

Master Offset

The Master Offset is the position offset that is currently applied to the master side of the position cam. The Master Offset is returned in master position units. The Master Offset will show the same unwind characteristic as the position of a linear axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Master Offset	REAL	Master Position Units

Strobe Master Offset

The Strobe Master Offset is the position offset that was applied to the master side of the position cam when the last Motion Group Strobe Position (MGSP) instruction was executed. The Strobe Master Offset is returned in master position units. The Strobe Master Offset will show the same unwind characteristic as the position of a linear axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Strobe Master Offset	REAL	Master Position Units

Start Master Offset

The Start Master Offset is the position offset that was applied to the master side of the position cam when the last Motion Axis Move (MAM) instruction with the move type set to "Absolute Master Offset" or "Incremental Master Offset" was executed. The Start Master Offset is returned in master position units. The Start Master Offset will show the same unwind characteristic as the position of a linear axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Start Master Offset	REAL	Master Position Units

Motion Status Bit Attributes

This section describes the various Motion Axis Object status bit attributes.

Motion Status Bits

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motion Status Bits	DINT	Direct Access Entire DINT - **MotionStatus** 0: Acceleration Status - **AccelStatus** 1: Deceleration Status - **DecelStatus** 2: Move Status - **MoveStatus** 3: Jog Status - **JogStatus** 4: Gearing Status - **GearingStatus** 5: Homing Status - **HomingStatus** 6: Stopping Status - **StoppingStatus** 7: Homed Status - **HomedStatus** 8: Position Cam Status - **PositionCamStatus** 9: Time Cam Status - **TimeCamStatus** 10: Position Cam Pending Status - PositionCamPendingStatus 11: Time Cam Pending Status **- TimeCamPendingStatus** 12: Gearing Lock Status **- GearingLockStatus** 13: Position Cam Lock Status **- PositionCamLockStatus** 14: *Reserved (Time Cam Lock Status)* - 15: Master Offset Move Status **- Master Offset MoveStatus** 16: Coordinated Motion Status - **CoordinatedMotionStatus** 17-31: *Reserved*

Acceleration/Deceleration Status

The Acceleration and Deceleration Status bit attributes can be used to determine if the axis is currently being commanded to accelerate or decelerate. If neither bit is set then the axis is running at steady state velocity or at rest.

Move Status

The Move Status bit attribute is set if a Move motion profile is currently in progress. As soon as the Move is complete or superseded by some other motion operation, the Move Status bit is cleared.

Jog Status

The Jog Status bit attribute is set if a Jog motion profile is currently in progress. As soon as the Jog is complete or superseded by some other motion operation, the Jog Status bit is cleared.

Gearing Status

The Gearing Status bit attribute is set if the axis is currently Gearing to another axis. As soon as the gearing operation is stopped or superseded by some other motion operation, the Gear Status bit is cleared.

Homing Status

The Homing Status bit attribute is set if a Home motion profile is currently in progress. As soon as the Home is complete or superseded by some other motion operation, the Home Status bit is cleared.

Stopping Status

The Stopping Status bit attribute is set if there is a stopping process currently in progress. As soon as the stopping process is complete, the Stopping Status bit is cleared. The stopping process is used to stop an axis (initiated by an MAS, MGS, MGPS, Stop Motion fault action, or mode change). This bit is no longer associated with the gearing Clutch bit (MAG with Clutch selected) which, for I4B, has been explicitly named the Gearing Lock Status bit.

Homed Status

The Homed Status bit attribute is cleared at power-up or reconnection. The bit is set to 1 by the MAH instruction upon successful completion of the configured homing sequence. This bit would be later cleared if the axis entered the shutdown state.

Position Cam Status

The Position Cam Status bit attribute is set if a Position Cam motion profile is currently in progress. As soon as the Position Cam is complete or superseded by some other motion operation, the Position Cam Status bit is cleared.

Time Cam Status

The Time Cam Status bit attribute is set if a Time Cam motion profile is currently in progress. As soon as the Time Cam is complete or superseded by some other motion operation, the Time Cam Status bit is cleared.

Position Cam Pending Status

The Position Cam Pending Status bit attribute is set if a Position Cam motion profile is currently pending the completion of a currently executing cam profile. This would be initiated by executing an MAPC instruction with Pending execution selected. As soon as the current position cam profile completes, initiating the start of the pending cam profile, the Position Cam Pending bit is cleared. This bit is also cleared if the position cam profile completes, or superseded by some other motion operation.

Time Cam Pending Status

The Time Cam Pending Status bit attribute is set if a Time Cam motion profile is currently pending the completion of a currently executing cam profile. This would be initiated by executing an MATC instruction with Pending execution selected. As soon as the current time cam profile completes, initiating the start of the pending cam profile, the Time Cam Pending bit is cleared. This bit is also cleared if the time cam profile completes, or superseded by some other motion operation.

Gearing Lock Status

The Gearing Lock Status bit attribute is set whenever the slave axis is locked to the master axis in a gearing relationship according to the specified gear ratio. The clutch function of the gearing planner is used to ramp an axis up, or down, to speed in a gearing process (MAG with Clutch selected). During the intervals where the axis is clutching, the Gearing Lock Status bit is clear.

Position Cam Lock Status

The Position Cam Lock Status bit attribute is set whenever the master axis satisfies the starting condition of a currently active Position Cam motion profile. The starting condition is established by the Start Control and Start Position parameters of the MAPC instruction. As soon as the current position cam profile completes, or is superseded by some other motion operation, the Position Cam Lock bit is cleared. In uni-directional master direction mode, the Position Cam Lock Status bit clears when moving in the “wrong” direction and sets when moving in the correct direction.

Master Offset Move Status

The Master Offset Move Status bit attribute is set if a Master Offset Move motion profile is currently in progress. As soon as the Master Offset Move is complete or superseded by some other motion operation, the Master Offset Move Status bit is cleared.

Coordinated Motion Status

The Coordinated Motion Status bit attribute is set if any coordinated motion profile is currently active upon this axis. As soon as the Coordinated Motion is complete or stopped, the The Coordinated Motion Status bit is cleared.

Axis Status Bit Attributes

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Axis Status Bits	DINT	Direct Access Entire DINT - **AxisStatus** 0: Servo Action Status -**ServoActionStatus** 1: Drive Enable Status -**DriveEnableStatus** 2: Axis Shutdown Status -**ShutdownStatus** 3: Configuration Update in Process **-ConfigUpdateInProcess** 4-31: *Reserved*

Servo Action Status

The Servo Action Status bit attribute is set when the associated axis is under servo control. If the bit is not set then servo action is disabled.

Drive Enable Status

The Drive Enable Status bit attribute is set when the Drive Enable output of the associated physical axis is currently enabled. If the bit is not set then physical servo axis Drive Enable output is currently disabled.

Shutdown Status

The Shutdown Status bit attribute is set when the associated axis is currently in the Shutdown state. As soon as the axis is transitioned from the Shutdown state to another state, the Shutdown Status bit is cleared.

Configuration Update in Process

The Configuration Update Status Bits attribute provides a method for monitoring the progress of one or more specific module configuration attribute updates initiated by either a Set Attribute List service or an SSV in the user program. As soon as such an update is initiated, the ControlLogix processor sets the "Configuration Update in Process" bit. The bit will remain set until the Set Attribute List reply comes back from the servo module indicating that the data update process was successful. Thus the Configuration Update Status Bits attribute provides a method of waiting until the servo configuration data update to the connected motion module is complete before starting a dependent operation.

Axis Fault Bit Attributes

All of the fault bit attributes defined below can be handled by the ControlLogix processor as a Major Fault by configuring the associated Group Object's "General Fault Type Mechanism" attribute accordingly. Otherwise any specific fault handling must be done as part of the user program.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Axis Fault Bits	DINT	Direct Access Entire DINT - **AxisFault** 0: Physical Axis Fault -**PhysicalAxisFault** 1: Module Fault - **ModuleFault** 2: Configuration Fault - **ConfigFault**

Physical Axis Fault

If the Physical Axis Fault bit is set, it indicates that there is one or more fault conditions have been reported by the physical axis. The specific fault conditions can then be determined through access to the fault attributes of the associated physical axis.

Module Fault

The Module Fault bit attribute is set when a serious fault has occurred with the motion module associated with the selected axis. Usually a module fault affects all axes associated with the motion module. A module fault generally results in the shutdown of all associated axes. Reconfiguration of the motion module is required to recover from a module fault condition.

Configuration Fault

The Configuration Fault bit is set when an update operation targeting an axis configuration attribute of an associated motion module has failed. Specific information concerning the Configuration Fault may be found in the Attribute Error Code and Attribute Error ID attributes associated with the motion module.

Module Fault Bit Attribute

The Module Fault Bit attribute is a collection of faults that have module scope as opposed to axis scope. Besides being a valid attribute for axes of data type Servo and Servo Drive, this attribute is also valid for a consumed axis data type. In this case, however, the module is the producing Logix processor rather than a motion module such as the 1756M02AE or 1756M08SE.

Thus, these fault bits are updated every coarse update period of the consuming Logix processor. The fault bit attributes defined below can be handled by the Logix processor as a Major Fault by configuring the associated Group Object's "General Fault Type Mechanism" attribute accordingly. Otherwise any specific fault handling must be done as part of the user program.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Module Fault Bits	DINT	Direct Access Entire DINT - **ModuleFaults** 0: Control Sync Fault -**ControlSyncFault** 1-31: *Reserved*

Control Sync Fault

The Control Sync Fault bit attribute is set when the Logix controller detects that several position update messages in a row from the producing controller have been missed due to a failure of the controller-to-controller communications connection. This condition results in the automatic shutdown of the associated servo module. The consuming Logix controller is designed to "ride-through" a maximum of four missed position updates without issuing a fault or adversely affecting motion in progress. Missing more than four position updates in a row constitutes a problematic condition that warrants shutdown of the servo module. The Control Sync Fault bit is cleared when the connection is reestablished.

Axis Event Bit Attributes

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
Template	Axis Event Bits	DINT	Direct Access Entire DINT - **AxisEvent** 0: Watch Event Armed Status -**WatchEventArmedStatus** 1: Watch Event Status -**WatchEventStatus** 2: Registration Event 1Armed Status -**RegEvent1ArmedStatus** 3: Registration Event 1Status -**RegEvent1Status** 4: Registration Event 2 Armed Status -**RegEvent2ArmedStatus** 5: Registration Event 2 Status -**RegEvent2Status** 6: Home Event Armed Status -**HomeEventArmedStatus** 7: Home Event Status -**HomeEventStatus** 8-31: *Reserved*

Watch Event Armed Status

The Watch Event Armed Status bit attribute is set when a watch event has been armed through execution of the MAW (Motion Arm Watch) instruction. This bit is cleared when either a watch event occurs or a MDW (Motion Disarm Watch) instruction is executed.

Watch Event Status

The Watch Event Status bit attribute is set when a watch event has occurred. This bit is cleared when either another MAW (Motion Arm Watch) instruction or a MDW (Motion Disarm Watch) instruction is executed.

Registration 1 Event Armed Status

The Registration 1 Event Armed Status bit attribute is set when a registration checking has been armed for registration input 1 through execution of the MAR (Motion Arm Registration) instruction. This bit is cleared when either a registration event occurs or a MDR (Motion Disarm Registration) instruction is executed for registration input 1.

Registration 1 Event Status

The Registration 1 Event Status bit attribute is set when a registration event has occurred on registration input 1. This bit is cleared when either another MAR (Motion Arm Registration) instruction or a MDR

(Motion Disarm Registration) instruction is executed for registration input 1.

Registration 2 Event Armed Status

The Registration 2 Event Armed Status bit attribute is set when a registration checking has been armed for registration input 2 through execution of the MAR (Motion Arm Registration) instruction. This bit is cleared when either a registration event occurs or a MDR (Motion Disarm Registration) instruction is executed for registration input 2.

Registration 2 Event Status

The Registration 2 Event Status bit attribute is set when a registration event has occurred on registration input 2. This bit is cleared when either another MAR (Motion Arm Registration) instruction or a MDR (Motion Disarm Registration) instruction is executed for registration input 2.

Home Event Armed Status

The Home Event Armed Status bit attribute is set when a home event has been armed through execution of the MAH (Motion Axis Home) instruction. This bit is cleared when a home event occurs.

Home Event Status

The Home Event Status bit attribute is set when a home event has occurred. This bit is cleared when another MAH (Motion Axis Home) instruction is executed.

Output Cam Status

The Output Cam Status bit is set when an Output Cam has been initiated. The Output Cam Status bit is reset when the cam position moves beyond the cam start or cam end position in “Once” execution mode with no Output Cam pending or when the Output Cam is terminated by a MDOC instruction.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Output Cam Status	DINT	Set of Output Cam Status bits

Output Cam Pending Status

The Output Cam Pending Status bit is set if an Output Cam is currently pending the completion of another Output Cam. This would be initiated by executing an MAOC instruction with Pending execution selected. As soon as this output cam is armed, being triggered when the currently executing Output Cam has completed, the Output Cam

Pending bit is cleared. This bit is also cleared if the Output Cam is terminated by a MDOC instruction.

Internal Access Rule	Attribute Name	ASA Data Type	Semantics of Values
GSV	Output Cam Pending Status	DINT	Set of Output Cam Pending Status bits

Output Cam Lock Status

The Output Cam Lock Status bit is set when an Output Cam has been armed. This would be initiated by executing an MAOC instruction with Immediate execution selected, when a pending output cam changes to armed, or when the axis approaches or passes through the specified axis arm position. As soon as this output cam current position moves beyond the cam start or cam stop position, the Output Cam Lock bit is cleared. This bit is also cleared if the Output Cam is terminated by a MDOC instruction.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Output Cam Lock Status	DINT	Set of Output Cam Lock Status bits

Output Cam Transition Status

The Output Cam Transition Status bit is set when a transition between the currently armed and the pending Output Cam is in process. Therefore, each Output Cam controls a subset of Output Bits. The Output Cam Transition Status bit is reset, when the transition to the pending Output Cam is complete or when the Output Cam is terminated by a MDOC instruction.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Output Cam Transition Status	DINT	Set of Output Cam Transition Status bits

Motion Object Configuration Attributes

The following sections define in more detail the behavior of all the various configuration attributes associated with the Motion axis Object. The attributes are, by definition, have read-write access. The Servo Object Configuration Attributes are divided into five categories: Motion General Configuration, Motion Units, Motion Conversion, Motion Homing, Motion Dynamics, and Motion Instruction attributes. These categories correspond roughly to the organization of the RSLogix 5000 Axis Properties pages.

Axis Type

The Axis Type attribute is used to establish the intended use of the axis. If the axis is intended for full servo operation than a value of “2”

is required. If only the position information from the feedback interface is of interest, than a Axis Type should be set to “1”. Finally, if the axis is unused in the application, which is a common occurrence when there are an odd number of axes in the system, then the Axis Type associated with the unused axis should be set to “0”. Axis Type is not only used to qualify many operations associated with the axis servo loop, it also controls the behavior of the servo module’s Axis Status LEDs. An Axis Type of “1” (Feedback Only) results in the DRIVE LED being blanked, while a value of “0” (Unused) blanks both the FDBK and DRIVE LEDs.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Axis Type	INT	Enumeration: 1 = feedback only 2 = servo

External software (RSLogix5000) also uses the current configured value for Axis Type to control the look of many of the tab dialogs associated with the axis configuration tool.

Motion Planner Configuration Attributes

The following configuration attributes apply to and control various aspects of the motion planner functionality.

Output Cam Execution Targets

The Output Cam Execution Targets attribute is used to specify the number of Output Cam nodes attached to the axis. This attribute can only be set as part of an axis create service and dictates how many Output Cam Nodes are created and associated to that axis. Each Output Cam Execution Target requires approximately 5.4k bytes of data table memory to store persistent data. With four Output Cam Execution Targets per axis, an additional 21.6k bytes of memory is required for each axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Output Cam Execution Targets	DINT	Represents the number of Output Cam nodes attached to this axis. Valid range = 0-8 with default of 0.

The ability to configure the number of Output Cam Execution Targets for a specific axis reduces the memory required per axis for users who do not need Output Cam functionality, or only need 1 or 2 Output Cam Execution Targets for a specific axis. Each axis can be configured differently.

Master Input Configuration Bits

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Master Input Configuration Bits	DINT	Bit Field: 0: Master Delay Compensation 1: Master Position Filter 2-31: *Reserved*

Master Delay Compensation

By default, both the Position Camming and Gearing functions, when applied to a slave axis, perform Master Delay Compensation to compensate for the delay time between reading the master axis command position and applying the associated slave command position to the input of the slave's servo loop. When the master axis is running at a fixed speed, this compensation technique insures that the slave axis command position accurately tracks the actual position of the master axis; in other words, Master Delay Compensation allows for zero tracking error when gearing or camming to the actual position of a master axis.

This feature, while necessary in many applications, doesn't come without a price. The Master Delay Compensation algorithm extrapolates the position of the master axis at the predicted time when the command position is applied to the slave's servo loop. Since master axis position is measured in discrete feedback counts and is inherently noisy, the extrapolation process amplifies that noise according to the total position update delay. The total position update delay is proportional to the Coarse Update Period of the motion group, and, if the master or the slave involves an AXIS_SERVO_DRIVE data type, it also includes the delay term that is proportional to the SERCOS Update Period. The greater the delay, the greater the noise introduced by the extrapolator.

The Master Delay Compensation feature also includes an extrapolation filter to filter the noise introduced by the extrapolation process. The time constant of the filter is fixed at 4x the total position update delay (independent of the Master Position Filter Bandwidth), which again is a function of the Coarse Update Period (and the SERCOS Update Period, if a AXIS_SERVO_DRIVE data type.

The Logix engine currently implements a 1^{st} order extrapolation algorithm that results in zero tracking error while the master axis is moving at constant velocity. If the master axis accelerates or decelerates the tracking error is non-zero and proportional to the acceleration or deceleration rate and also proportional to the square of the total position update delay time. Clearly, from both a noise and acceleration error perspective, minimizing the coarse update period is vital.

In some applications there is no requirement for zero tracking error between the master and the slave axis. In these cases, it may be beneficial to disable the Master Delay Compensation feature to eliminate the disturbances the extrapolation algorithm introduces to the slave axis. When the Master Delay Compensation feature is disabled (bit cleared), the slave axis will appear to be more responsive to movements of the master, and run generally smoother than when Master Delay Compensation feature is enabled (bit set). However, when the master axis is running at a constant velocity, the slave will lag the master by a tracking error that is proportional to the speed of the master.

Note that Master Delay Compensation, even if explicitly enabled, is not applied in cases where a slave axis is gearing or camming to the master axis' command position. Since the Logix controller generates the command position directly, there is no intrinsic master position delay to compensate for.

Master Position Filter

The Master Position Filter bit controls the activity of an independent single-poll low-pass filter that effectively filters the specified master axis position input to the slave's gearing or position camming operation. When enabled (bit set), this filter has the effect of smoothing out the actual position signal from the master axis, and thus smoothing out the corresponding motion of the slave axis. The trade-off for smoothness is an increase in lag time between the response of the slave axis to changes in motion of the master. Note that the Master Position Filter also provides filtering to the extrapolation noise introduced by the Master Delay Compensation algorithm, if enabled.

When the Master Position Filter bit is set, the bandwidth of the Master Position Filter is controlled by the Master Position Filter Bandwidth attribute, see below. This can be done by setting the Master Position Filter bit and controlling the Master Position Filter Bandwidth directly. Setting the Master Position Filter Bandwidth to zero can be used to effectively disable the filter.

Master Position Filter Bandwidth

The Master Position Filter Bandwidth attribute controls the activity of the single-poll low-pass filter that filters the specified master axis position input to the slave's gearing or position camming operation. When enabled, this filter has the effect of smoothing out the actual position signal from the master axis, and thus smoothing out the corresponding motion of the slave axis. The trade-off for smoothness

is an increase in lag time between the response of the slave axis to changes in motion of the master.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Master Position Filter Bandwidth	REAL	Hertz

If the Master Position Filter is disabled, the Master Position Filter Bandwidth has no effect.

Motion Unit Configuration Attributes

Position Units

The Axis Object allows user-defined engineering units rather than feedback counts to be used for measuring and programming all motion-related values (position, velocity, etc.). These position units can be different for each axis and should be chosen for maximum ease of use in your application. For example, linear axes might use position units of Inches, Meters, or mm while rotary axes might use units of Revs or Degrees.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Position Units	STRING	Fixed length string of 32 characters

The Position Units attribute can support an ASCII text string of up to 32 characters. This string is used by RSLogix 5000 software in the axis configuration dialogs to request values for motion-related parameters in the specified Position Units.

Average Velocity Timebase

The Average Velocity Timebase attribute is used to specify the desired time in seconds to be used for calculating the Average Velocity of the axis. When the Average Velocity Value is requested, the value is computed by taking the total distance traveled by the axis in the amount of time given by the Average Velocity Timebase and dividing this value by the timebase.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Average Velocity Timebase	REAL	Sec

The Average Velocity Timebase value should be large enough to filter out the small changes in velocity which would otherwise result in a “noisy” velocity value, but small enough to track significant changes in axis velocity. Typically, a value between 0.25 and 0.5 seconds works well for most applications

Motion Conversion Configuration

Conversion Constant

To allow axis position to be displayed and motion to be programmed in the position units specified by the Position Unit string attribute, a Conversion Constant must be established for each axis. The Conversion Constant, sometimes known as the K constant, allows the Axis Object to convert the axis position units into feedback counts and vice versa. Specifically, K is the number of feedback counts per Position Unit.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Conversion Constant	REAL	Counts / Position Unit Range: 0.1 - $1e^{12}$ Default: 8000.0

Note that the 1756M02AE encoder based servo module uses 4X encoder feedback decoding (both edges of channel A and B are counted). The count direction is determined from both the direction of the edge and the state of the opposite channel. Channel A leads channel B for increasing count. This is the most commonly used decode mode with incremental encoders, since it provides the highest resolution.

For example, suppose this servo axis utilizes a 1000 line encoder in a motor coupled directly to a 5 pitch lead screw (5 turns per inch). With a user defined Position Unit of Inches, the conversion constant is calculated as shown below:

K = 1000 Lines/Rev * 4 Counts/Line * 5 Revs/Inch = 20,000 Counts/Inch.

Caution: If 'Conversion Constant' is changed it invalidates all of the settable attributes with "Position Unit" conversions in "Semantics of Values" column. To be valid the 'Conversion Constant' must be set to the desired value prior to setting (including defaulting) any of the affected attributes.

Rotary Axis

When the Rotary Axis attribute is set true (1), it enables the rotary unwind capability of the axis. This feature provides infinite position range by unwinding the axis position whenever the axis moves through a complete physical revolution. The number of encoder counts per physical revolution of the axis is specified by the Position Unwind attribute. If the Rotary Axis attribute is false (0), indicating

linear operation, the maximum total linear excursion is limited to 1 Billion feedback counts before rolling over to zero.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Rotary Axis	SINT	0 = Linear 1 = Rotary

Position Unwind If the axis is configured as a rotary axis by setting the corresponding Rotary Axis bit Servo Configuration Bit word, a value for the Position Unwind attribute is required. This is the value used to perform automatic electronic unwind of the rotary axis. Electronic unwind allows infinite position range for rotary axes by subtracting the unwind value from both the actual and command position every time the axis makes a complete revolution. To avoid accumulated error due to round-off with irrational conversion constants the unwind value is requested in units feedback counts per axis revolution and must be an integer.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Unwind	DINT	Counts per Revolution

For example, suppose that a given axis is configured as a Rotary Axis with Position Units of “Degrees” and 10 feedback counts per degree. It is desired to unwind the axis position after every revolution. In this case, the Position Unwind attribute should be set to 3600 since there are 3600 feedback counts (10 * 360) per revolution of the axis.

Motion Homing Configuration

Home Mode

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Home Mode	SINT	Enumeration: 0 = passive 1 = active (default) 2 = absolute

There are currently three Homing Modes supported by the Motion Axis Object, active, passive, and absolute. Active homing is the most common homing procedure for physical servo axes.

Passive

Passive homing redefines the current absolute position of the axis on the occurrence of a home switch or encoder marker event. Passive homing is most commonly used to calibrate uncontrolled axes, although it can also be used with controlled axes to create a custom homing sequence. Passive homing, for a given home sequence, works similar to the corresponding active homing sequence, as described below, except that no motion is commanded–the controller just *waits* for the switch and marker events to occur. If the configured feedback type does not support a marker signal, the “marker” and “switch then marker” homing sequences are not be applicable.

Active

When active homing is chosen as the homing mode, the desired homing sequence is then selected by specifying whether or not a home limit switch and/or the encoder marker is used for this axis. Active homing sequences always use the trapezoidal velocity profile. The Home Sequence attribute section below describes the available active homing sequences. If the configured feedback type does not support a marker signal, the “marker” and “switch then marker” homing sequences are not be applicable.

Absolute

If the motion axis hardware supports an absolute feedback device, a Homing Mode of “absolute” may be used. The only valid Home Sequence for an absolute Homing Mode is “immediate”. In this case, the absolute homing process establishes the true absolute position of the axis by applying the configured Home Position to the reported position of the absolute feedback device. Prior to execution of the absolute homing process via the MAH instruction, the axis must be in the Axis Ready state with the servo loop disabled. (This restriction currently applies only to Axis Servo Drive data types).

Home Sequence and Home Direction

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Home Direction	SINT	Enumeration: 0 = uni-directional forward 1 = bi-directional forward 2 = unidirectional reverse 3 = bi-directional reverse
SSV/GSV	Home Sequence	SINT	Enumeration: 0 = immediate (default) 1 = switch 2 = marker 3 = switch then marker

Active Homing

Active homing sequences, with the exception of the "Immediate" home sequence type, employ trapezoidal jog velocity profiles to move the axis while waiting for a homing event to occur. When "Active" is the configured Home Mode, the Home Sequence attribute is used to specify whether or not a home limit switch and/or the feedback device marker is to be used for the homing events. The Home Direction attribute determines the directional behavior of jog profiles associated with the specified homing sequence. Uni-directional and Bi-directional refer whether or not the jog is to reverse direction after detecting the homing event. Forward and Reverse refer to the direction of the initial jog during the homing process. The available active homing sequences are described in detail below with the assumption that the Home Direction is always forward.

Active Immediate Home

This is the simplest active homing sequence type. When this sequence is performed, the controller immediately enables the servo drive and assigns the Home Position to the current axis actual position and command position. This homing sequence produces no axis motion and the Home Offset attribute is not applicable.

Active Bi-directional Home with Switch

This active homing sequence is useful when an encoder marker is not available. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed until the home limit switch is detected. The axis then decelerates to a stop and then moves in the opposite direction at the specified Home Return Speed until the home limit switch is cleared. When the home limit switch is cleared, axis position is immediately redefined to be equal to the Home Position and the axis decelerates to a stop. If Home Offset is non-zero, then the Home Position is offset from the point where the home switch is cleared by this value. Once the axis decelerates to a

stop, the controller then moves the axis back to the Home Position at the Home Return Speed using a trapezoidal move profile. If the axis is configured as a Rotary Axis, the move back to the Home Position takes the shortest path (i.e., no more than ½ revolution). The motions for this active homing sequence are shown below.

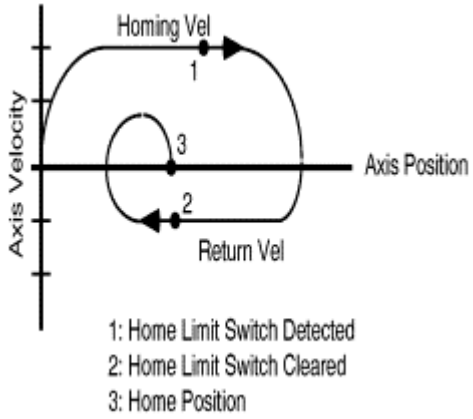


Figure 13.3 Home Limit Switch

If the controller detects that the state of the home switch at the start of the homing sequence is active, the controller immediately reverses the homing direction and begins the return leg of the homing sequence.

Neglecting the mechanical uncertainty of the home limit switch, the accuracy of this homing sequence depends on the time uncertainty in detecting the home limit switch transitions. The position uncertainty of the home position is the product of the maximum time for the control to detect the home limit switch (~10 milliseconds) and the specified Home Return Speed. For this reason, the Home Return Speed is often made significantly slower than the Home Speed.

For example, if a Home Return Speed of 0.1 inches per second (6 IPM) is specified, the uncertainty of the home position is calculated as shown below:

Uncertainty = 0.1 Inch/Sec * 0.01 Sec = 0.001 Inch.

Active Bi-directional Home with Marker

This active homing sequence is useful for single turn rotary and linear encoder applications since these have only one encoder marker for full axis travel. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed until the marker is detected. The Home Position is then assigned to the axis position corresponding to the marker location, and the axis decelerates to a stop. If Home Offset is non-zero, then the Home Position is offset from the point where the marker is detected by this value. The controller then moves the axis back to the Home Position

at the specified Home Return Speed using a trapezoidal move profile. If the axis is configured as a Rotary Axis, the move back to the Home Position takes the shortest path (i.e., no more than ½ revolution). The axis behavior for this homing sequence is shown below.

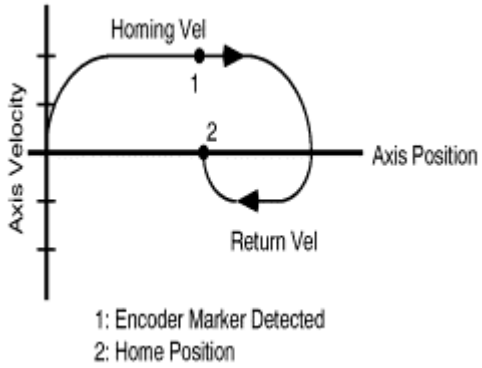


Figure 13.4 Bi-directional Marker

The accuracy of this homing sequence depends only on the time delay in detecting the marker transition. The position uncertainty of the home position is the product of the maximum delay for the control to detect the marker pulse (~1 microsecond) and the specified Home Speed.

For example, if a Home Speed of 1 inches per second (60 IPM) is specified, the uncertainty of the home position is calculated as shown below:

Uncertainty = 1 Inch/Sec * 0.000001 Sec = 0.000001 Inch.

Clearly, using the marker pulse as part of the homing sequence results in a tremendous increase in absolute homing accuracy over just employing mechanical limit switches.

Active Bi-directional Home with Switch then Marker

This is the most precise active homing sequence available. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed until the home limit switch is detected. The axis then decelerates to a stop and moves in the opposite direction at the specified Home Return Speed until the home limit switch is cleared. After clearing the home limit switch, the axis continues in the same direction at the Home Return Speed until the first encoder marker is detected. The Home Position is assigned to the axis position at the moment that the marker is detected, and the axis then decelerates to a stop. If Home Offset is non-zero, then the Home Position is offset from the point where the marker is detected by this value. The controller then moves the axis back to the Home Position at the specified Home Return Speed using a trapezoidal move profile. If the axis is configured as a Rotary Axis, the move back to the Home

Position takes the shortest path (i.e., no more than ½ revolution). Axis behavior for this homing sequence is shown below.

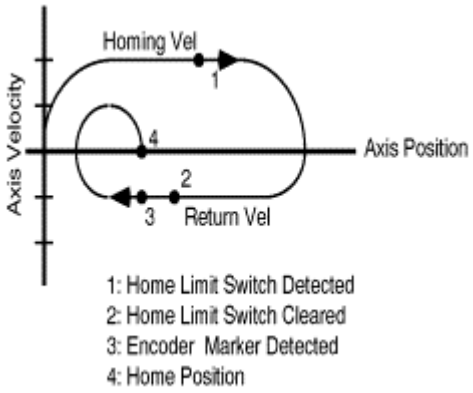


Figure 13.5 Limit Switch Encoder Marker

If the controller detects that the state of the home switch at the start of the homing sequence is active, the controller immediately reverses the homing direction and begins the return leg of the homing sequence.

Active Uni-directional Home with Switch

This active homing sequence is useful for when an encoder marker is not available and either uni-directional motion is required or proximity switch is being used.

When this sequence is performed in the Active Homing Mode, the axis moves in the specified Home Direction at the specified Home Speed until the home switch is detected. The Home Position is assigned to the axis position at the moment that the limit switch is detected. If Home Offset is non-zero, then the Home Position is offset from the point where the switch is detected by this value. The controller then continues to move the axis to the Home Position at the specified Home Speed using a trapezoidal move profile. By setting a Home Offset greater than the deceleration distance, unidirectional motion to the Home Position is insured. However, if the Home Offset value is less than the deceleration distance, then the axis is simply decelerated to a stop. The axis does NOT reverse direction to move to the Home Position. In this case, the PC-bit leg of the associated MAH instruction is not set when the IP-bit leg is cleared.

In the case where this homing sequence is performed on a rotary axis and the Home Offset value is less than the deceleration distance when the home event is detected, the control automatically adds one or more revolutions to the move distance. This guarantees the resulting move to the Home Position is unidirectional.

Active Uni-directional Home with Marker

This active homing sequence is useful for single turn rotary and linear encoder applications when uni-directional motion is required.

When this sequence is performed in the Active Homing Mode, the axis moves in the specified Home Direction at the specified Home Speed until the marker is detected. The Home Position is assigned to the axis position at the moment that the marker is detected. If Home Offset is non-zero, then the Home Position is offset from the point where the marker was detected by this value. The controller then continues to move the axis to the Home Position at the specified Home Speed using a trapezoidal move profile. By setting a Home Offset greater than the deceleration distance, unidirectional motion to the Home Position is insured. However, if the Home Offset value is less than the deceleration distance, then the axis is simply decelerated to a stop. The axis does NOT reverse direction to move to the Home Position. In this case, the PC-bit leg of the associated MAH instruction is not set when the IP-bit leg is cleared.

In the case where this homing sequence is performed on a rotary axis and the Home Offset value is less than the deceleration distance when the home event is detected, the control automatically adds one or more revolutions to the move distance. This guarantees the resulting move to the Home Position is unidirectional.

Active Uni-directional Home with Switch then Marker

This active homing sequence is useful for multi-turn rotary applications when uni-directional motion is required.

When this sequence is performed in the Active Homing Mode, the axis moves in the specified Home Direction at the specified Home Speed until the home switch is detected. The axis continues in the same direction at the Home Speed until the first marker event is detected. The Home Position is assigned to the axis position at the precise position where the marker was detected, and the axis then decelerates to a stop. If Home Offset is non-zero, then the Home Position is offset from the point where the marker was detected by this value. The controller then continues to move the axis to the Home Position at the specified Home Speed using a trapezoidal move profile. By setting a Home Offset greater than the deceleration distance, unidirectional motion to the Home Position is insured. However, if the Home Offset value is less than the deceleration distance, then the axis is simply decelerated to a stop. The axis does NOT reverse direction to move to the Home Position. In this case, the PC-bit leg of the associated MAH instruction is not set when the IP-bit leg is cleared.

In the case where this homing sequence is performed on a rotary axis and the Home Offset value is less than the deceleration distance when the home event is detected, the control automatically adds one or more revolutions to the move distance. This guarantees the resulting move to the Home Position is unidirectional.

Passive Homing

Passive Immediate Home

This is the simplest passive homing sequence type. When this sequence is performed, the controller immediately assigns the Home Position to the current axis actual position. This homing sequence produces no axis motion.

Passive Home with Switch

This passive homing sequence is useful for when an encoder marker is not available or a proximity switch is being used.

When this sequence is performed in the Passive Homing Mode, an external agent moves the axis until the home switch is detected. The Home Position is assigned to the axis position at the moment that the limit switch is detected. If Home Offset is non-zero, then the Home Position is offset from the point where the switch is detected by this value.

Passive Home with Marker

This passive homing sequence is useful for single turn rotary and linear encoder applications.

When this sequence is performed in the Passive Homing Mode, an external agent moves the axis until the marker is detected. The home position is assigned to the axis position at the precise position where the marker was detected. If Home Offset is non-zero, then the Home Position is offset from the point where the switch is detected by this value.

Passive Home with Switch then Marker

This passive homing sequence is useful for multi-turn rotary applications.

When this sequence is performed in the Passive Homing Mode, an external agent moves the axis until the home switch and then the first encoder marker is detected. The home position is assigned to the axis position at the precise position where the marker was detected. If Home Offset is non-zero, then the Home Position is offset from the point where the switch is detected by this value.

Home Configuration Bits

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Home Configuration Bits	DINT	0: (Reserved) 1: Home Switch Normally Closed 2: (Reserved) 3-31: *Reserved*

Home Switch Normally Closed

The Home Switch Normally Closed bit attribute determines the normal state of the home limit switch used by the homing sequence. The normal state of the switch is its state prior to being engaged by the axis during the homing sequence. For example, if the Home Switch Normally Closed bit is set (true) then the condition of the switch prior to homing is closed. When the switch is engaged by the axis during the homing sequence, the switch is opened, which constitutes a homing event. Refer to the Homing Sequence configuration attribute described earlier in this section.

Home Position The Home Position is the desired absolute position for the axis after the specified homing sequence has been completed. After an active homing sequence has completed, the axis is left at the specified Home Position.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Home Position	REAL	Position Units

In most cases, Home Position is set to zero, although any value, within the Maximum Positive and Negative Travel limits of the axis (if enabled), may also be used. (A description of the Maximum Positive and Negative Travel configuration attributes may be found in the Servo and Drive Axis Object specifications). For a rotary axis, the Home Position is constrained to be a positive number less than the Position Unwind value divided by the Conversion Constant.

When configured for absolute Homing Mode, the Home Position value is applied directly to the absolute feedback device to establish an absolute position reference for the system.

Home Offset When applied to an active or passive Homing Mode, using a non-immediate Home Sequence, the Home Offset is the desired position offset of the axis Home Position from the position at which the home event occurred. The Home Offset is applied at the end of

the specified homing sequence before the axis moves to the Home Position. In most cases, Home Offset is set to zero.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Home Offset	REAL	Position Units

After an active bi-directional homing sequence has completed, the axis is left at the specified Home Position. If the Home Offset is non-zero, the axis will then be offset from the marker or home switch event point by the Home Offset value. If the Home Offset is zero, the axis will sit right "on top of" the marker or home switch point.

Home Speed The Home Speed attribute controls the speed of the jog profile used in the first leg of an active homing sequence as described in the above discussion of the Home Sequence Type attribute.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Home Speed	REAL	Position Units / Sec

Home Return Speed The Home Return Speed attribute controls the speed of the jog profile used after the first leg of an active bi-directional homing sequence as described in the above discussion of the Home Sequence Type attribute.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Home Return Speed	REAL	Position Units / Sec

InhibitAxis Inhibits or uninhibts an axis.

Attribute	Data type	Instruction	Description	
InhibitAxis	INT	GSV SSV	**To**	**Set the attribute to**
			Block the controller from using the axis. This inhibits the axis.	1 or any non-zero value
			Let the controller use the axis. This uninhibit the axis.	0

Motion Dynamics Configuration

Maximum Speed The value of the Maximum Speed attribute is used by various motion instructions (e.g. MAJ, MAM, MCD, etc.) to determine the steady-state

speed of the axis. These instructions all have the option of specifying speed as a percent of the Maximum Speed attribute value for the axis. The Maximum Speed value for the axis is automatically set to the Tuning Speed by the MAAT (Motion Apply Axis Tune) instruction. This value is typically set to ~90% of the maximum speed rating of the motor. This provides sufficient "head-room" for the axis to operate at all times within the speed limitations of the motor.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Maximum Speed	REAL	Position Units / Sec

Maximum Acceleration/Deceleration

The Maximum Acceleration and Deceleration attribute values are frequently used by motion instructions such as MAJ, MAM, MCD, etc., to determine the acceleration and deceleration rates to apply to the axis. These instructions all have the option of specifying acceleration and deceleration as a percent of the Maximum Acceleration and Maximum Deceleration attributes for the axis. The Maximum Acceleration and Maximum Deceleration values for the axis are automatically set to ~ 85% of the measured Tune Acceleration and Tune Deceleration by the MAAT (Motion Apply Axis Tune) instruction. If set manually, these values should typically be set to ~85% of the maximum acceleration and maximum deceleration rate of the axis. This provides sufficient "head-room" for the axis to operate at all times within the acceleration and deceleration limits of the drive and motor.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Maximum Acceleration	REAL	Position Units / Sec^2
SSV/GSV	Maximum Deceleration	REAL	Position Units / Sec^2

Programmed Stop Mode

The Programmed Stop Mode attribute value determines how a specific axis will stop when the ControlLogix processor undergoes a critical processor mode change or when an explicit MGS (Motion Group Stop) instruction executed with it's stop mode set to 'programmed'. There are currently four modes defined for the ControlLogix processor: Program Mode, Run Mode, Test Mode and Faulted Mode. Any mode change into or out of program mode (prog->run, prog->test, run->prog & test->prog) will initiate a programmed stop for every axis owned by that processor. Each individual axis can have

its own Programmed Stop Mode configuration independent of other axes. Three methods of stopping a given axis are currently supported.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Programmed Stop Mode	SINT	Enumeration: 0 = Fast Stop (default) 1 = Fast Disable 2 = Hard Disable 3 = Fast Shutdown 4 = Hard Shutdown

Fast Stop

When the Programmed Stop Mode attribute is configured for Fast Stop, the axis is decelerated to a stop using the current configured value for Maximum Deceleration. Servo action is maintained after the axis motion has stopped.

Fast Disable

When the Programmed Stop Mode attribute is configured for Fast Disable, the axis is decelerated to a stop using the current configured value for Maximum Deceleration. Servo action is maintained until the axis motion has stopped at which time the axis is disabled, i.e. Drive Enable disabled, and Servo Action disabled

Hard Disable

When configured for Hard Disable, the axis is immediately disabled, i.e. Drive Enable disabled, Servo Action disabled, but the OK contact is left closed. Unless the drive is configured to provide some form of dynamic breaking, this results in the axis coasting to a stop.

Fast Shutdown

When configured for Fast Shutdown, the axis is decelerated to a stop as with Fast Stop but, once the axis motion is stopped, the axis is placed in the Shutdown state, i.e. Drive Enable disabled, servo action disabled, and the OK contact opened. To recover from the Shutdown state requires execution of one of the axis or group Shutdown Reset instructions (MASR or MGSR).

Hard Shutdown

When configured for Hard Shutdown, the axis is immediately placed in the Shutdown state, i.e. Drive Enable disabled, Servo Action disabled, and the OK contact opened. Unless the drive is configured to provide some form of dynamic breaking, this results in the axis

coasting to a stop. To recover from the Shutdown state requires execution of one of the axis or group Shutdown Reset instructions (MASR or MGSR).

Servo Status Attributes

The following sections define the behavior of the various status attributes associated with the Servo specific behavior of the Motion Axis Object. Status attributes are, by definition, read access only. The following Servo specific Status Attributes are divided into 3 categories: Servo Status attributes, Servo Commissioning Status attributes, and Servo Status Bit attributes.

The list of Servo Status Attributes associated with the Axis Object provides access to the servo module resident information for the axis. These values may be used as part of the user program to perform real time measurements of servo operation. A list of all Servo Status Attributes is shown in the tables below.

Since Servo Status Attributes values are resident in the axis' servo module, these values need to be transferred to the ControlLogix processor module on a regular basis. To avoid unnecessary communication traffic transferring data that is not of interest, it is necessary to explicitly activate transfer of the specific Servo Status Attribute data from the servo module using the Axis Info Select attributes. Thus, a Servo Status Attribute value is **ONLY** valid if the attribute has been selected by one of the Axis Info Select attributes. Otherwise the Servo Status Attribute value is forced to zero.

In order for the position unit-based servo status attributes to return a meaningful value, the 'Conversion Constant' Axis Configuration Attribute must be established. Furthermore, attributes having velocity or acceleration units (Position Units / Sec) must also have a valid coarse update period which is established through association with a fully configured Motion Group Object.

Each of the Servo Status Attributes appears in the following Servo block diagram.

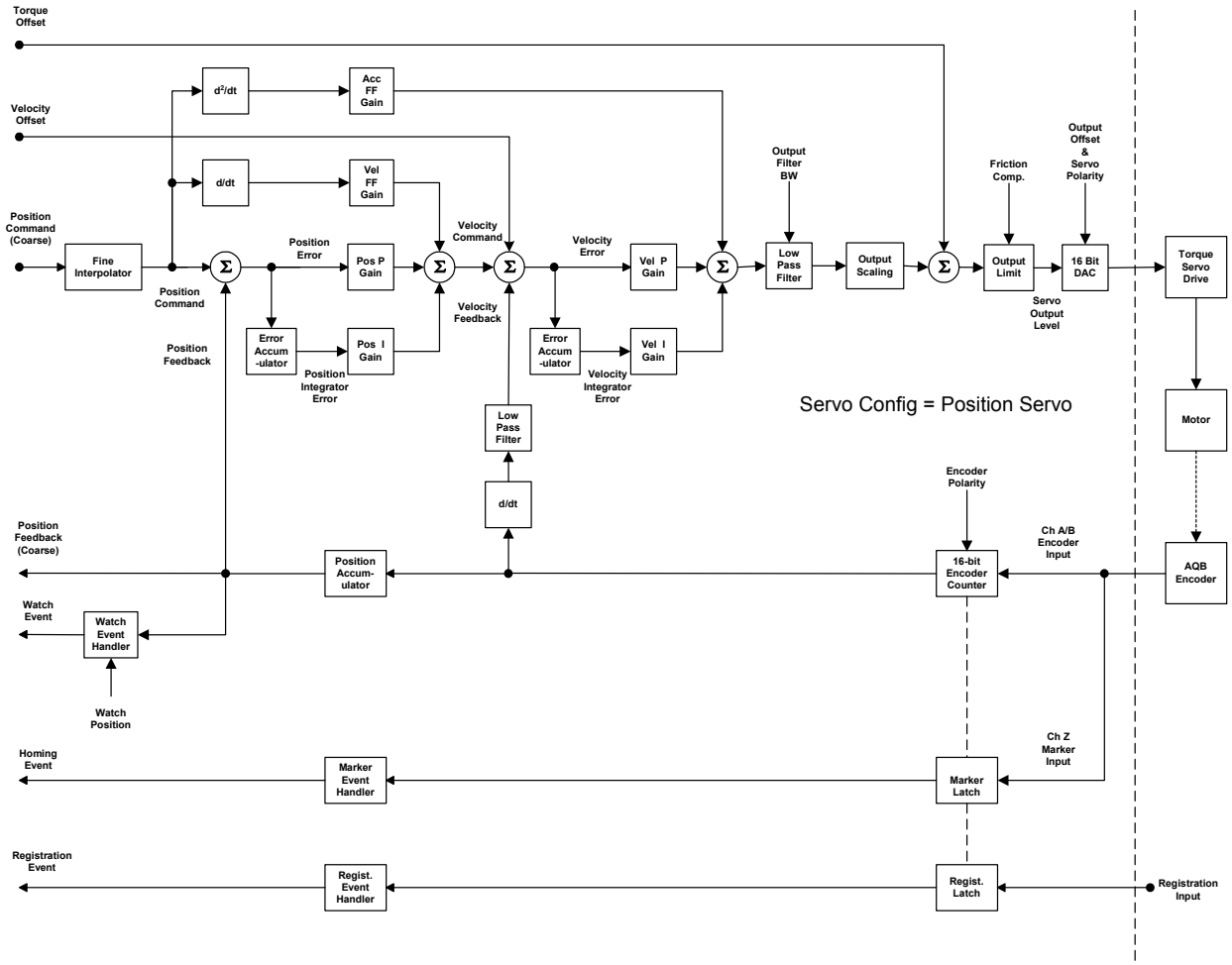


Figure 13.6 Servo Loop with Servo Attributes

Position Command

Position Command is the current value of the Fine Command Position into the position loop summing junction, in configured axis Position Units. Within the active servo loop, the Position Command value is used to control the position of the axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Command	REAL	Position Units

Position Feedback

Position Feedback is the current value of the Fine Actual Position into the position loop summing junction, in configured axis Position Units.

Within the servo loop, the Position Feedback represents the current position of the axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Feedback	REAL	Position Units

Aux Position Feedback

Aux Position Feedback is the current value of the position feedback coming from the auxiliary feedback input. This value is not supported in the first release..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Aux Position Feedback	REAL	Position Units

Position Error

Position Error is the difference, in configured axis Position Units, between the command and actual positions of a servo axis. For an axis with an active servo loop, position error is used, along with other error terms, to drive the motor to the condition where the actual position is equal to the command position.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Error	REAL	Position Units

Position Integrator Error

Position Integrator Error is the running sum of the Position Error, in the configured axis Position Units, for the specified axis. For an axis with an active servo loop, the position integrator error is used, along with other error terms, to drive the motor to the condition where the actual position is equal to the command position.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Integrator Error	REAL	Position Units - mSec

Velocity Command

Velocity Command is the current velocity reference to the velocity servo loop, in the configured axis Position Units per Second, for the specified axis. The Velocity Command value, hence, represents the output of the outer position control loop. Velocity Command is not to be confused with Command Velocity, which represents the rate of change of Command Position input to the position servo loop.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Velocity Command	REAL	Position Units / Sec

Velocity Feedback

Velocity Feedback is the actual velocity of the axis as estimated by the servo module, in the configured axis Position Units per Second. The Estimated Velocity value is computed by applying a 1 KHz low-pass filter to the change in actual position over the servo update interval. Velocity Feedback is a signed value—the sign (+ or -) depends on which direction the axis is currently moving. .

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Velocity Feedback	REAL	Position Units / Sec

Velocity Error

Velocity Error is the difference, in configured axis Position Units per Second, between the commanded and actual velocity of a servo axis. For an axis with an active velocity servo loop, velocity error is used, along with other error terms, to drive the motor to the condition where the velocity feedback is equal to the velocity command..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Velocity Error	REAL	Position Units / Sec

Velocity Integrator Error

Velocity Integrator Error is the running sum of the Velocity Error, in the configured axis Position Units per Second, for the specified axis. For an axis with an active velocity servo loop, the velocity integrator error is used, along with other error terms, to drive the motor to the condition where the velocity feedback is equal to the velocity command.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Velocity Integrator Error	REAL	Position Units – mSec / Sec

Acceleration Command

Acceleration Command is the current acceleration reference to the output summing junction, in the configured axis Position Units per $Second^2$, for the specified axis. The Acceleration Command value, hence, represents the output of the inner velocity control loop. Acceleration Command is not to be confused with Command Velocity, which represents the rate of change of Command Position input to the position servo loop.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Acceleration Command	REAL	Position Units / Sec^2

Acceleration Feedback

Acceleration Feedback is the actual velocity of the axis as estimated by the servo module, in the configured axis Position Units per Second^2. The Estimated Acceleration is calculated by taking the difference in the Estimated Velocity over the servo update interval. Acceleration Feedback is a signed value—the sign (+ or -) depends on which direction the axis is currently moving.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Acceleration Feedback	REAL	Position Units / Sec^2

Servo Output Level

Servo Output Level is the current voltage level of the servo output of the specified axis. The Servo Output Level can be used in drilling applications, for example, where the servo module is interfaced to an external Torque Loop Servo Drive, to detect when the drill bit has engaged the surface of the work piece.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Servo Output Level	REAL	Volts

Marker Distance

Marker Distance is the distance between the axis position at which a home switch input was detected and the axis position at which the marker event was detected. This value is useful in aligning a home limit switch relative to a feedback marker pulse to provide repeatable homing operation.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Marker Distance	REAL	Position Units

Servo Status Bit Attributes

This section describes the various Servo Axis Object status bit attributes.

Servo Status Bit Attributes

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Servo Status Bits	DINT	Direct Access Entire DINT - **ServoStatus** 0: Servo Action Status -*No Tag* 1: Drive Enable Status -***No Tag*** 2: Axis Shutdown Status -*No Tag* 3: Process Status -**ProcessStatus** 4: Output Limit Status -**OutputLimitStatus** 5: Position Lock Status -**PositionLockStatus** 6: Home Input Status -**HomeInputStatus** 7: Registration 1 Input Status -**Reg1Input Status** 8: Registration 2 Input Status -**Reg2InputStatus** 9: Positive Overtravel Input Status -**PosOvertravelInputStatus** 10: Negative Overtravel Input Status -**NegOvertravelInputStatus** 12-15: *Reserved* 16-31: *Reserved*

Servo Action Status

The Servo Action Status bit attribute is set when servo action is currently enabled on the associated axis. If the bit is not set then servo action is disabled.

Drive Enable Status

The Drive Enable Status bit attribute is set when the Drive Enable output of the associated physical axis is currently enabled. If the bit is not set then physical servo axis Drive Enable output is currently disabled.

Shutdown Status

The Shutdown Status bit attribute is set when the associated axis is currently in the Shutdown state. As soon as the axis is transitioned from the Shutdown state to another state, the Shutdown Status bit is cleared.

Process Status

The Process Status bit attribute is set when there is an axis tuning operation or an axis hookup diagnostic test operation in progress on the associated physical axis.

Output Limit Status

The Output Limit Status bit attribute is set when the magnitude of the output of the associated physical servo axis has reached or exceeded the configured Output Limit value. If this bit is not set then the magnitude of the servo output is within the configured Output Limit value.

Position Lock Status

The Position Lock Status bit attribute is set when the magnitude of the axis position error has become less than or equal to the configured Position Lock Tolerance value for the associated physical axis. If this bit is not set then the magnitude of the axis position error is greater than the configured Position Lock Tolerance value.

Home Input Status

The Home Input Status bit attribute represents the current state of the dedicated Home input. This bit is set if the Home input is active and clear if inactive.

Registration 1/2 Input Status

The Registration Input 1 and Registration Input 1 Status bit attributes represent the current state of the corresponding dedicated Registration input. This bit is set if the registration input is active and clear if inactive.

Positive Overtravel Input Status

The Positive Overtravel Input Status bit attribute represents the current state of the dedicated Positive Overtravel input. This bit is set if the Positive Overtravel input is active and clear if inactive.

Negative Overtravel Input Status

The Negative Overtravel Input Status bit attribute represents the current state of the dedicated Negative Overtravel input. This bit is set if the Negative Overtravel input is active and clear if inactive.

Axis Control Bit Attributes

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Axis Control Bits	DINT	0: Abort Process Request 1: Shutdown Request 3: Zero DAC Request 4-14: *Reserved* 15: Change Cmd Reference 16-31: *Reserved*

Abort Process Request

When the Abort Process bit is set, the servo module disables any active process, such as a tuning or test process.

Shutdown Request

When the Shutdown Request bit is set, the servo module forces the axis into the shutdown state which opens the OK contact and zeroes the DAC output.

Zero DAC Request

When the Zero DAC Request bit is set, the servo module forces the DAC output for the axis to zero volts. This bit only has an affect if the axis is in the Direct Drive State with the drive enabled but no servo action.

Abort Home Request

When the Abort Home Request bit is set, any active homing procedures are cancelled.

Abort Event Request

When the Abort Event Request bit is set, any active registration or watch event procedures are cancelled.

Change Cmd Reference

The Change Command Reference Request bit attribute is set when the Logix processor has switched to a new position coordinate system for command position. The servo module processor uses this bit when processing new command position data from the Logix processor to account for the offset implied by the shift in the reference point. The bit is cleared when the Servo module acknowledges completion of the reference position change by clearing its Change Position Reference bit

Axis Response Bit Attributes

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Axis Control Bits	DINT	0: Abort Process Acknowledge 1: Shutdown Acknowledge 2: Zero DAC Acknowledge 3: Abort Home Acknowledge 4: Abort Event Acknowledge 5-14: *Reserved* 15: Change Pos Reference 16-31: *Reserved*

Abort Process Acknowledge

When the Abort Process Acknowledge bit is set, the servo module acknowledges that the tuning or test process has been aborted

Shutdown Request Acknowledge

When the Shutdown Acknowledge bit is set, the servo module acknowledges that the axis has been forced into the shutdown state.

Zero DAC Request Acknowledge

When the Zero DAC Acknowledge bit is set, the servo module acknowledges that the DAC output for the axis has been set to zero volts.

Abort Home Acknowledge

When the Abort Home Acknowledge bit is set, the servo module acknowledges that the active home procedure has been aborted.

Abort Event Acknowledge

When the Abort Home Acknowledge bit is set, the servo module acknowledges that the active registration or watch position event procedure has been aborted.

Change Pos Reference

The Change Position Reference bit attribute is set when the Servo loop has switched to a new position coordinate system. The Logix processor to uses this bit when processing new position data from the servo module to account for the offset implied by the shift in the reference point. The bit is cleared when the Logix processor acknowledges completion of the reference position change by clearing its Change Cmd Reference bit.

Servo Fault Bit Attributes

The Servo Fault Bits attribute is a collection of all fault attributes that are associated with the servo axis. Servo Fault Bit attributes are passed from a servo module to the controller via a 32-bit value in the Synchronous Input connection axis data structure. Thus, these fault bits are updated every coarse update period.

All of the fault bit attributes defined below can be handled by the ControlLogix processor as a Major Fault by configuring the associated Group Object's "General Fault Type Mechanism" attribute accordingly. Otherwise any specific fault handling must be done as part of the user program.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Servo Fault Bits	DINT	Direct Access Entire DINT - **ServoFault** 0: Positive Soft Overtravel Fault -**PosSoftOvertravelFault** 1: Negative Soft Overtravel Fault -**NegSoftOvertravelFault** 2: Positive Hard Overtravel Fault -**PosHardOvertravelFault** 3: Negative Hard Overtravel Fault -**NegHardOvertravelFault** 4: Feedback Fault -**FeedbackFault** 5: Feedback Noise Fault -**FeedbackNoiseFault** 6: Auxiliary Feedback Fault -**AuxFeedbackFault** 7: Auxiliary Feedback Noise Fault -**AuxFeedbackNoiseFault** 8: Position Error Fault -**PositionErrorFault** 9: Drive Fault -**DriveFault** 13-31: *Reserved*

Positive/Negative Soft Overtravel Status

If either the Positive Overtravel Status or Negative Overtravel Status bit attributes are set it indicates that the axis has traveled, or attempted to travel, beyond the current configured values for Maximum Positive Travel or Maximum Negative Travel, respectively. As soon as the axis is moved back within these travel limits, the corresponding Overtravel Status bit is cleared.

Positive/Negative Hardware Overtravel Faults

If either the Positive Hard Overtravel Status or Negative Hard Overtravel Status bit attributes are set it indicates that the axis has traveled beyond the current position limits as established by hardware

limit switches mounted on the machine. To recover, the axis must be moved back with normal operation limits of the machine and the limit switch reset. This fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear.

Feedback Fault

If the Feedback Fault bit is set for a specific feedback source, it indicates that one of the following conditions occurred:

The differential electrical signals for one or more of the feedback channels (e.g., A+ and A-, B+ and B-, or Z+ and Z- for an A Quad B encoder) are at the same level (both high or both low). Under normal operation, the differential signals are always at *opposite* levels. The most common cause of this situation is a broken wire between the feedback transducer and the servo module or drive.

Loss of feedback “power” or feedback “common” electrical connection between the servo module or drive and the feedback device.

This fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear.

Feedback Noise Fault

If the Feedback Noise Fault bit attribute is set for a specific feedback source, it indicates that noise has been detected on the feedback devices signal lines. For example, simultaneous transitions of the feedback A and B channels of an A Quad B is referred to generally as feedback noise. In this case, feedback noise (shown below) is most often caused by loss of quadrature in the feedback device itself or radiated common-mode noise signals being picked up by the feedback device wiring, both of which may be able to be seen on an oscilloscope.

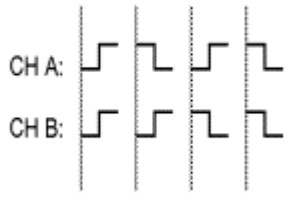


Figure 13.7 Feedback Noise

For example, loss of channel quadrature for an encoder can be caused by physical misalignment of the feedback transducer components, or excessive capacitance (or other delays) on the encoder signals. Proper

grounding and shielding techniques can usually cure radiated noise problems. This fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear.

Position Error Fault

If the Position Error Fault bit attribute is set it indicates that the servo has detected that the axis position error has exceeded the current configured value for Position Error Tolerance. This fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear.

Drive Fault

If the Drive Fault bit attribute is set it indicates that the external servo drive has detected a fault and has indicated such to the servo module via the Drive Fault input. This fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear.

Module Fault Bit Attributes

The Module Fault Bit attribute is a collection of all faults that have module scope as opposed to axis scope. Generally, a these module faults are reflected by all axes supported by the given servo module.

Module Fault attribute information is passed from a physical module or device to the controller via an 8-bit value contained in the in the header of the Synchronous Input connection assembly. Thus, these fault bits are updated every coarse update period by the Motion Task. The module's map driver should also monitor module Faults so module fault conditions can be reflected to the user through the Module Properties dialog.

All of the fault bit attributes defined below can be handled by the ControlLogix processor as a Major Fault by configuring the associated Group Object's "General Fault Type Mechanism" attribute accordingly.

Otherwise any specific fault handling must be done as part of the user program.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Servo Module Fault Bits	DINT	Direct Access Entire DINT - **ServoModuleFault** 0: Control Sync Fault -**ControlSyncFault** 1: Module Sync Fault -**ModuleSyncFault** 2: Timer Event Fault -**TimerEventFault** 3: Module Hardware Fault -**ModuleHardwareFault** 4-31: *Reserved*

Control Sync Fault

The Control Sync Fault bit attribute is set when the Logix controller detects that several position update messages in a row from the motion module have been missed due to a failure of the synchronous communications connection. This condition results in the automatic shutdown of the associated servo module. The Logix controller is designed to “ride-through” a maximum of four missed position updates without issuing a fault or adversely affecting motion in progress. Missing more than four position updates in a row constitutes a problematic condition that warrants shutdown of the servo module. The Synchronous Connection Fault bit is cleared when the connection is reestablished.

Module Sync Fault

The Module Sync Fault bit attribute is set when the motion module detects that several position update messages in a row from the ControlLogix processor module have been missed due to a failure of the synchronous communications connection. This condition results in the automatic shutdown of the servo module. The servo module is designed to “ride-through” a maximum of four missed position updates without issuing a fault or adversely affecting motion in progress. Missing more than four position updates in a row constitutes a problematic condition that warrants shutdown of the servo module. The Synchronous Connection Fault bit is cleared when the connection is reestablished.

Timer Event Fault

If the Timer Event Fault bit attribute is set it indicates that the associated servo module has detected a problem with the module’s timer event functionality used to synchronize the motion module’s servo loop to the master timebase of the Logix rack (i.e. Coordinated

System Time). The Timer Event Fault bit can only be cleared by reconfiguration of the motion module.

Module Hardware Fault

If the Module Hardware Fault bit attribute is set it indicates that the associated servo module has detected a hardware problem that, in general, is going to require replacement of the module to correct.

Attribute Error Code .

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Attribute Error Code	INT	ASA Error code returned by erred set attribute list service to the module. (See Appendix B)

When an Axis Configuration Fault occurs, one or more axis parameters associated with a servo module or device has not been successfully updated to match the value of the corresponding parameter of the local controller. The fact that the configuration of the servo axis no longer matches the configuration of the local controller is a serious fault and results in the shutdown of the faulted axis. The Attribute Error Code is reset to zero by reconfiguration of the motion module.

Axis Configuration Fault information is passed from the servo module or device to the controller via a 16-bit ASA status word contained in the Set Attribute List service response received by the controller. A Set Attribute List service to the motion module can be initiated by a software Set Attribute List service to the controller, or by an SSV instruction within the controller's program, referencing a servo attribute. Various routines that process responses to motion services are responsible for updating these attributes.

The Set and Get service responses provide a status response with each attribute that was processed. That status value is defined by ASA as follows: UINT16, Values 0-255 (0x00-0xFF) are reserved to mirror common service status codes. Values 256 – 65535 are available for object/class attribute specific errors. For a list of ASA error codes see Appendix B.

Attribute Error ID

The Attribute Error ID is used to retain the ID of the servo attribute that returned a non-zero attribute error code resulting in an Axis Configuration Fault. The Attribute Error ID defaults to zero and, after a

fault has occurred may be reset to zero by reconfiguration of the motion module.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Attribute Error ID	INT	Attribute ID associated with non-zero Attribute Error Code.

Commissioning Status Attributes

The list of Commissioning Status Attributes associated with the Axis Object provides access to attributes associated with the state of various motion instruction generated commissioning processes. Motion instructions involved in commissioning an axis are MRAT (Motion Run Axis Tune) and MRHD (Motion Run Hookup Diagnostic) which are described in detail in the AC Motion Instruction Specification. Commissioning Status Attributes are primarily used by external software (e.g. RSLogix5000) to implement the Test and Tuning dialogs associated with the axis configuration tool. However, these same attributes may also be used as part of the user program to implement a "built-in" axis test and tuning procedure. A list of all Commissioning Status Attributes are shown in the tables below.

In order for the position unit-based attributes to return a meaningful value, the 'Conversion Constant' Axis Configuration Attribute must be established. Furthermore, attributes having time units (Position Units / Sec) must also have a valid coarse update period which is established through association with a fully configured Motion Group Object.

Test Status

The Test Status attribute returns status of the last run MRHD (Motion Run Hookup Diagnostic) instruction that initiates a hookup diagnostic process on the targeted servo module axis. The Test Status attribute can be used to determine when the MRHD initiated operation has successfully completed. Conditions may occur, however, that make it impossible for the control to properly perform the operation. When this is the case, the test process is automatically aborted and a test fault reported that is stored in the Test Status output parameter.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Test Status	INT	Enumeration: 0 = test process successful 1 = test in progress 2 = test process aborted by user 3 = test process time-out fault (~2 seconds) 4 = test process failed due to servo fault

Test Direction Forward

The Test Direction Forward attribute reports the direction of axis travel during hookup test as seen by the servo module during the last test process initiated by a MRHD (Motion Run Hookup Test) instruction. A Test Direction value of 1 (forward) indicates that the direction of motion as observed by the servo module was in the forward (or positive) direction. Note that the value for Test Direction, as determined by the MRHD process, does not depend on the Servo Polarity Bits configuration prior to executing the test. The Test Direction Forward attribute, when combined with the Test Output Polarity, is used by the MAHD (Motion Apply Hookup Test) instruction to properly configure the Servo Polarity Bits attribute for negative feedback and correct directional sense.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Test Direction Forward	SINT	0 = reverse 1 = forward

Test Output Direction

The Test Output Polarity attribute reports the sign of the output voltage applied to the drive during the last test process initiated by a MRHD (Motion Run Hookup Test) instruction. A Test Output Polarity value of 0 (positive) indicates that the sign of the voltage applied by the servo module during the test was positive. A Test Output Polarity value of 1 (negative) indicates that the sign of voltage applied by the servo module during the test was negative. This condition occurs when the hookup test is unsuccessful in moving the required Test Increment while applying a positive voltage. This situation can occur when testing a linear axis that is against a hard stop.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Test Output Polarity	SINT	0 = positive 1 = negative

Tune Status

The Tune Status attribute returns status of the last run MRAT (Motion Run Axis Tuning) instruction that initiates a tuning process on the targeted servo module axis. The Tune Status attribute can, thus, be used to determine when the MRAT initiated operation has successfully completed. Conditions may occur, however, that make it impossible for the control to properly perform the operation. When this is the

case, the tune process is automatically aborted and a tune fault reported that is stored in the Tune Status output parameter.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Status	INT	Enumeration: 0 = tune process successful 1 = tune in progress 2 = tune process aborted by user 3 = tune process time-out fault 4 = tune process failed due to servo fault 5 = axis reached Tuning Travel Limit 6 = axis polarity set incorrectly

Tune Acceleration/Deceleration Time

The Tune Acceleration Time and Tune Deceleration Time attributes return acceleration and deceleration time in seconds for the last run MRAT (Motion Run Axis Tune) instruction. These values are used to calculate the Tune Acceleration and Tune Deceleration attributes.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Acceleration Time	REAL	Sec
GSV	Tune Deceleration Time	REAL	Sec

Tune Acceleration/Deceleration

The Tune Acceleration Time and Tune Deceleration attributes return the measured acceleration and deceleration values for the last run MRAT (Motion Run Axis Tuning) instruction. These values are used, in the case of an external torque servo drive configuration, to calculate the Tune Inertia value of the axis, and are also typically used by a subsequent MAAT (Motion Apply Axis Tune) to determine the tuned values for the Maximum Acceleration and Maximum Deceleration attributes.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Acceleration	REAL	Position Units / Sec2
GSV	Tune Deceleration	REAL	Position Units / Sec2

Tune Speed Scaling

The Tune Speed Scaling attribute returns the axis drive scaling factor measured during the last executed MRAT (Motion Run Axis Tune) instruction. This value is only applicable to axes configured for interface to an external velocity servo drive. In this case, the Tune

Speed Scaling attribute value is directly applied to the Velocity Scaling attribute by a subsequent MAAT (Motion Apply Axis Tune) instruction.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Speed Scaling	REAL	% / KiloCounts Per Sec

Tune Rise Time

The Tune Rise Time attribute returns the axis rise time as measured during the last executed MRAT (Motion Run Axis Tune) instruction. This value is only applicable to axes configured for interface to an external velocity servo drive. In this case, the Tune Rise Time attribute value is used to calculate the Tune Velocity Bandwidth.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Rise Time	REAL	Sec

Tune Inertia

When the axis is configured for interface to a external torque servo drive, the Tune Inertia value represents the total inertia for the axis as calculated from the measurements made during the last MRAT (Motion Run Axis Tune) initiated tuning process. In actuality, the units of Tune Inertia are not industry standard inertia units but rather in terms of percent (%) of full-scale servo output per MegaCounts/Sec^2 of feedback input. In this sense it represents the input gain of torque servo drive. These units represent a more useful description of the inertia of the system as seen by the servo controller. The Tune Inertia value is used by the MAAT (Motion Apply Axis Tune) instruction to calculate the Torque Scaling attribute.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Inertia	REAL	% / MegaCounts Per Sec^2

If the Tune Inertia value exceeds 100%Rated/MegaCounts Per Second^2, performance of the digital servo loop may be compromised due to excessive digitization noise associated with the velocity estimator. This noise is amplified by the Torque Scaling gain, which is related to the Tune Inertia factor and passed on to the torque output of the drive. A high Tune Inertia value can, thus, result in excitation of mechanical resonances and also result in excessive heating of the motor due to high torque ripple. The only solution to this problem is to lower the loop bandwidths and optionally apply some output filtering.

Since the Tune Inertia value represents a measure of the true system inertia, this situation can occur when driving a high inertia load relative to the motor, i.e. a high inertia mismatch. But it can also occur

when working with a drive that is undersized for the motor or with a system having low feedback resolution. In general, the lower the Tune Inertia the better the performance of the digital servo loops will approximate that of an analog servo system.

Enhancements have been made to the Logix tuning algorithm to address excessive noise issues by managing quantization noise levels. The product of the Tune Inertia (% Rated/MCPS) and the Velocity Servo BW (Hertz) can be calculated to directly determine quantization noise levels. Based on this product, the tuning algorithm can take action to limit high frequency noise injection to the motor. These are the actions that have been recently implemented:

For motors with a Tune Inertia BW product of 1000 or more, the LP Filter is applied with a Filter BW of 5x the Velocity Servo Bandwidth in Hertz. This will limit the amount of phase lag introduced by the LP filter to ~12 degrees which is relatively small compared to the 30 to 60 degrees of phase margin that we have for a typical tuned servo system. With a typical tuned LP filter BW value of 200 Hz, we can expect the high frequency quantization noise in the 1 KHz range to be attenuated roughly by a factor of 5.

When the Tune Inertia BW product reaches 4000 or more, the LP filter alone is not going to be enough to manage the quantization noise level. So the tune algorithm is going to taper the system bandwidth by the ratio of 4000/(Tune Inertia * Vel Servo BW). This will hold the quantization noise level at a fixed value, independent of the Tune Inertia BW product. For example, a resolver based AB-420G motor with a Tune Inertia value of 213 and a Vel Servo BW of 41 Hz (8733 Inertia BW product) will tune with a Pos P Gain of 46 and a Vel P Gain of 117 and LP Filter BW of 93. This has been found to be a good noise free gain set.

Servo Configuration Attributes

The following sections define in more detail the behavior of all the various configuration attributes associated with the Servo Axis Object. The attributes are, by definition, have read-write access. The Servo Object Configuration Attributes are divided into six categories: Feedback Configuration, Servo Configuration, Servo Gains, Servo Limits, Servo Offsets, and Servo Commissioning attributes. These categories correspond roughly to the organization of the RSLogix 5000 Axis Properties pages.

Feedback Configuration

Axis position feedback is derived from the motion module's feedback interface hardware. Depending on the specific motion module, the feedback interface may be an A Quadrature B encoder (AQB), a Synchronous Serial Interface (SSI), or a Linear Displacement Transducer (LDT).

Feedback configuration is accomplished by first establishing the feedback interface type of the associated servo module using the Feedback Type attribute of the Motion Axis Object.

Servo Feedback Type This attribute provides a selection for the Feedback Type. Enumerations are LDT – Linear Displacement Transducer, SSI – Synchronous Serial Interface, and AQB – A Quadrature B. When LDT is selected, only parameters applicable to an LDT Transducer are valid. When SSI is selected, only parameters applicable to an SSI Transducer are valid.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Servo Feedback Type	SINT	Enumeration: 0 = AQB 1 = SSI 2 = LDT

A Quadrature B Encoder Interface (AQB)

Servo modules, such as the 1756M02AE, provide interface hardware to support incremental quadrature encoders equipped with standard 5-Volt differential encoder interface signals. This interface hardware provides a robust differential encoder input interface to condition each of the encoder signals before being applied to an Encoder-to-Digital Converter (EDC) FPGA. The EDC decodes the encoder signals and uses a 16-bit bi-directional counter to accumulate feedback counts. A regular Timer Event signal, applied to the EDC, latches the encoder counters for all axes simultaneously. This same Timer Event signal also triggers the servo interrupt service routine that performs the servo loop computations. One of the first things done by the interrupt service routine is to read the latched encoder counter values from the EDC. The change in the encoder counter value from the last timer event is computed and this delta value is added to a 32-bit signed integer position accumulator, which represents the Actual Position of the axis. The Actual Position value is used as feedback to the position servo loop and as input to the Watch Event Handler as shown in the above servo diagrams. The delta position value represents velocity feedback, which when configured to do so, may be filtered and applied to the inner velocity servo loop.

Synchronous Serial Interface (SSI)

Some servo modules, like the 1756-M02AS, provide an interface to transducers with Synchronous Serial Interface (SSI) outputs. SSI outputs use standard 5V differential signals (RS422) to transmit information from the transducer to the controller. The signals consist of a Clock generated by the controller and Data generated by the transducer.

Each transducer with an SSI output provides output data of a specified number of bits of either Binary or Gray code data. The controller must generate a stream of clock pulses with the correct number of bits and a frequency within the range supported by the transducer. The servo module can be configured via the Servo Axis Object to generate any number of clock pulses between 8 and 32, and the frequency can be set to either 208kHz or 650kHz. The clock signal is maintained in the High state between pulse strings.

The transducer shifts data out on the Data line MSB first on each rising edge of the clock signal. The transducer also maintains the data signal in specified states before and after the data is shifted out. These states are checked by the controller to detect missing transducers or broken wires.

A Field Programmable Gate Array (FPGA) is used to implement a multi-channel SSI Interface on the controller. Each channel is functionally equivalent.

Linear Displacement Transducer (LDT)

Servo modules like the 1756-HYD02 is the Linear Magnetostrictive Displacement Transducer, or LDT. A Field Programmable Gate Array (FPGA) is used to implement a multi-channel LDT Interface. Each channel is functionally equivalent and is capable of interfacing to an LDT device with a maximum count of 240,000. The LDT interface has transducer failure detection and digital filtering to reduce electrical noise.

The FPGA can interface to two types of LDTs: Start/Stop and PWM. Start/Stop transducers accept an input (interrogate) signal to start the measurement cycle and respond with two pulses on the Return line. The time between the pulses is proportional to the position. PWM transducers respond to the interrogate signal with a single long pulse on the Return line. The pulse width is proportional to the position.

The FPGA generates the Interrogate signal every Servo Update time and measures the time between the Start/Stop pulses or the PWM pulse width. The resolution of the position measurement is determined by the frequency of the clock used for the time measurement. In the 1756-HYD02 design, a 60 MHz clock is used, and both edges of the clock signal are used for an effective time resolution of 8.3 nanoseconds. This translates into a position resolution better than 0.001 inch.

Note: It is possible to achieve higher resolutions with PWM transducers that are configured to perform multiple internal measurements (recirculations) and report the sum of those measurements in the pulse width.

LDT Type This attribute provides a selection for the LDT Type. It provides the following enumerated values: PWM, Start/Stop Rising, and Start/Stop Falling. This attribute is only active if the Transducer Type is set to LDT.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	LDT Type	SINT	Enumeration: 0 = PWM 1 = Start/Stop Rising 2 = Start/Stop Falling

LDT Recirculations This attribute provides the number of recirculations. This attribute is only active if the Transducer Type is set to LDT and LDT Type is set to PWM.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	LDT Recirculations	SINT	

LDT Calibration Constant This attribute provides for setting a calibration constant for LDT devices. This attribute is only active if the Transducer Type is set to LDT.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
	LDT Calibration Constant	REAL	

LDT Calibration Constant Units This attribute provides a selection for the units of the LDT calibration constant attribute. This attribute is only active if the Transducer Type is set to LDT.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	LDT Calibration Constant Units	SINT	Enumeration: 0 = m/sec 1 = Usec/in

LDT Scaling This attribute provides for setting the scaling factor for LDT devices. This attribute is only active if the Transducer Type is set to LDT.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	LDT Scaling	REAL	

LDT Scaling Units This attribute provides a selection for the units of the LDT scaling attribute. This attribute is only active if the Transducer Type is set to LDT.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	LDT Scaling Units	SINT	Enumeration: 0 = UU/m 1 = UU/in

LDT Length This attribute provides for setting the length of an LDT device. This attribute is only active if the Transducer Type is set to LDT.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	LDT Length	REAL	

LDT Length Units This attribute provides a selection for the units of the LDT length attribute. This attribute is only active if the Transducer Type is set to LDT.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	LDT Length Units	SINT	Enumeration: 0 = m 1 = in

SSI Code Type This attribute provides for setting the whether the SSI device is using Binary or Gray code. This attribute is only active if the Transducer Type is set to SSI.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	SSI Code Type	SINT	Enumeration: 0 = Binary 1 = Gray

SSI Data Length This attribute provides for setting the data length of the SSI device. This attribute is only active if the Transducer Type is set to SSI.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	SSI Data Length	SINT	

SSI Clock Frequency This attribute provides for setting the Clock Frequency in kHz of the SSI device. It provides the following enumerated values: 208, or 650 KHz. This attribute is only active if the Transducer Type is set to SSI.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	SSI Clock Frequency	SINT	Enumeration: 0 = 208Khz 1 = 650KHz

SSI Overflow Detection This attribute provides for setting whether overflow detection is enabled on the SSI device. This attribute is only active if the Transducer Type is set to SSI.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	SSI Overflow Detection	SINT	Enumeration: 0 = Disabled 1 = Enabled

Absolute Feedback Enable This attribute controls whether or not the servo module utilizes the absolute position capability of the feedback device. If Absolute Feedback Enable is set to True, the servo module adds the Absolute Feedback Offset to the current position of the feedback device to establish the absolute machine reference position. Since absolute feedback devices retain their position reference even through a power-cycle, the machine reference system can be restored at power-up. .

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Absolute Feedback Enable	SINT	Boolean

To establish a suitable value for the Absolute Feedback Offset attribute the MAH instruction may be executed with the Home Mode configured for Absolute (the only valid option when Absolute Feedback Enable is True). When executed, the servo module will compute the Absolute Feedback Offset as the difference between the configured value for Home Position and the current absolute feedback position of the axis. The computed Absolute Feedback Offset is immediately applied to the axis upon completion of the MAH instruction. Because the actual position of the axis is re-referenced during execution of the MAH instruction, the servo loop must not be active. If the servo loop is active the MAH instruction errors.

If Absolute Feedback Enable is set to False, the servo module ignores the Absolute Feedback Offset and treats the feedback device as an incremental position transducer. In this case, a homing or redefine

position operation is therefore needed to establish the absolute machine reference position. The Absolute Home Mode in this case is considered invalid.

This attribute is configurable if the Transducer Type is set to SSI. For an LDT transducer the Absolute Feedback Enable is forced to True. For an AQB transducer the Absolute Feedback Enable is forced to False.

Absolute Feedback Offset

This attribute is used to determine the relative distance between the absolute position of the feedback device and the absolute position of the machine. At power-up this attribute is sent to the servo module and added to the current position of the feedback device to restore the absolute machine position reference.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Absolute Feedback Offset	REAL	Position Units

If the axis is configured for Linear operation, absolute position may be recovered after power cycle as long as the feedback device has not exceeded its range limit. If the feedback device rolls over its count range, the absolute position of the axis is no longer valid.

If the axis is configured for Rotary operation, the servo module is responsible for adjusting the Absolute Feedback Offset dynamically based on the configured Unwind value and the rollover of the absolute feedback device. If necessary, absolute position may be recovered after power cycle by periodically updating the controller's Absolute Feedback Offset value. This can be done by selecting the Absolute Feedback Offset enumeration for one of the Axis Info Select attributes.

This attribute is only active if the Absolute Feedback Enable attribute is True.

Servo Configuration

Each of the following Servo Configuration attributes are associated with corresponding attributes contained in the ICP Servo Axis Object associated with servo module such as the 1756M02AE 2-Axis Servo module. When any of these attributes are modified by a Set Attribute List service or an SSV instruction within the user program, the local processor value for the attribute is immediately changed and a Set Attribute List service to the servo module is initiated to update the working value stored in the servo module. The progress of this update can be monitored, if necessary, within the user program through the ConfigUpdateInProcess.

The following Servo Configuration attributes provide basic servo loop configuration information.

Servo Loop Configuration

The Servo Loop Configuration attribute determines the specific configuration of the servo loop topology when the Axis Type is set to “servo”. While the only options supported at the time for initial release of this object are the position servo and the velocity servo configurations, other future configurations of the servo loop, such as a “dual feedback servo” and “dual command servo”, will eventually be supported. When the Axis Type is set to “feedback only”, the Servo Loop Configuration is used to select which feedback port is to be used. Initial release of this object however will not support the auxiliary feedback port.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Servo Loop Configuration	INT	Enumeration: 0 = custom 1 = feedback only 2 = aux. feedback only 3 = position servo 4 = aux. position servo 5 = dual position servo 6 = dual command servo 7 = aux. dual command servo 8 = velocity servo 9 = torque servo

The Servo Loop Configuration attribute determines the specific configuration of the servo loop topology when the Axis Type is set to “servo”. While the only options supported at the time for initial release of this object are the position servo and the velocity servo configurations, other future configurations of the servo loop, such as a “dual feedback servo” and “dual command servo”, will eventually be supported. When the Axis Type is set to “feedback only”, the Servo Loop Configuration is used to select which feedback port is to be used. Initial release of this object however will not support the auxiliary feedback port.

External Drive Type

When the application requires the servo module axis to interface with an external velocity servo drive, the External Drive Type should be configured for “velocity servo drive”. This disables the servo module’s internal digital velocity loop. If the External Drive Type attribute is set to “torque servo drive” the servo module’s internal digital velocity loop is active. This configuration is the required configuration for interfacing to a torque loop servo drive. If the External Drive Type attribute is set to “hydraulic servo” the object will enable certain features specific to hydraulic servo applications. In general, selecting

the hydraulic External Drive Type configures the servo loop the same as selecting the velocity servo External Drive Type.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	External Drive Type	DINT	Enumeration: 0 = torque servo 1 = velocity servo 2 = hydraulic servo

Fault Configuration Bits

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Fault Configuration Bits	DINT	Bit Field: 0 = Soft Overtravel Checking 1 = Drive Fault Checking 3-31 = Reserved Soft Overtravel Checking for Linear Axis only; Change to rotary or Overtravel Checking requires Home range checks.

Soft Overtravel Checking

When the Soft Overtravel Checking bit is set it enables a periodic test that monitors the current position of the axis and issues a Positive Overtravel Fault or Negative Overtravel Fault if ever the axis position travels outside the configured travel limits. The travel limits are determined by the configured values for the Maximum Positive Travel and Maximum Negative Travel attributes. This software overtravel check is not a substitute, but rather a supplement, for hardware overtravel fault protection which uses hardware limit switches to directly stop axis motion at the drive and deactivate power to the system. If the Soft Overtravel Checking bit is clear (default), then no software overtravel checking is done.

Software overtravel checking is only available for a linear servo axes.

Hard Overtravel Checking

When the Hard Overtravel Checking bit is set it enables a periodic test that monitors the current state of the positive and negative overtravel limit switch inputs and issues a Positive Hard Overtravel Fault or Negative Hard Overtravel Fault if ever the axis position travels activates the limit switch inputs. If the Hard Overtravel Checking bit is clear (default), then no overtravel limit switch input checking is done.

Hardware overtravel checking is only available for a linear servo axes.

Drive Fault Checking

The 1756-M02AE servo module provides a dedicated drive fault input for each axis. These inputs may be connected to fault outputs on the external drive (if provided) to notify the servo module of a fault in the drive itself. Set the Drive Fault Checking bit if you are using the servo module's drive fault input, and then specify the drive fault contact configuration of the amplifier's drive fault output as described below.

Drive Fault Normally Closed

The Drive Fault Normally Closed bit attribute controls the sense of the Drive Fault input to the servo module. If this bit is set (true) then during normal (fault-free) operation of the drive, the Drive Fault input should be active, i.e. 24 Volts. If a drive fault occurs, the drive will open its drive fault output contacts and remove 24 Volts from the servo module's Drive Fault input generating an axis Drive Fault condition. This is the default "fail-safe" configuration. In some cases it may be necessary to clear the Drive Fault Normally Closed bit to interface with a drive system that closes its contacts when faulted. This is generally not recommended for "fail-safe" operation.

Axis Info Select

Axis Info Select attributes are used to enable periodic data updates for selected servo status attributes. This method of accessing servo status data is designed to reduce the flow of unnecessary data for the Servo module. By selecting the servo status attribute of interest from the enumerated list, this attribute's value is transmitted along with the actual position data to the Logix processor. Thus, the servo status data update time is precisely the coarse update period. Once the servo status attributes of interest are periodically updated in this fashion, the values of these attributes may be accessed via the standard GSV or Get Attribute List service. Note, if a GSV is done to one of these servo status attributes without the having selected this attribute via the Axis

Info Select attribute, the attribute value is static and will not reflect the true value in the servo module.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Axis Info Select 1 Axis Info Select 2	DINT	Enumeration: 0 = None (default) 1 = Position Command 2 = Position Feedback 3 = Aux Position Feedback 4 = Position Error 5 = Position Int. Error 6 = Velocity Command 7 = Velocity Feedback 8 = Velocity Error 9 = Velocity Int. Error 10 = Accel. Command 11 = Accel. Feedback 12 = Servo Output Level 13 = Marker Distance 14-24 = (reserved) 25 = Absolute Offset

Servo Polarity Bits

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Servo Polarity Bits	DINT	Enumeration: 0: Feedback Polarity Negative 1: Servo Polarity Negative 2-31: *Reserved*

Feedback Polarity Negative

This Feedback Polarity Negative bit attribute controls the polarity of the encoder feedback and, when properly configured, insures that when the axis is moved in the user defined positive direction that the axis Actual Position value increases. This bit can be configured automatically using the MRHD and MAHD motion instructions. Refer to the AC Motion Instruction Specification for more information on these hookup diagnostic instructions.

Servo Polarity Negative

This Servo Polarity Negative bit attribute controls the polarity of the servo output to the drive. When properly configured along with the Feedback Polarity Negative bit, it insures that when the axis servo loop is closed that it is closed as a negative feedback system and not an unstable positive feedback system. This bit can be configured automatically using the MRHD and MAHD motion instructions. Refer

to the AC Motion Instruction Specification for more information on these hookup diagnostic instructions.

Servo Loop Block Diagrams

The following section illustrates the various servo loop configurations that are supported with the first release of this object. Which of these servo loop topologies is in effect depends on the current settings of the of the Servo Loop Configuration and External Drive Type attributes.

Position Servo with Torque Servo Drive

This configuration provides full position servo control using an external torque loop servo drive. Synchronous input data to the servo loop includes Position Command, Velocity Offset, and Torque Offset. These values are updated at the coarse update rate of the associated motion group. The Position Command value is derived directly from the output of the motion planner, while the Velocity Offset and Torque Offset values are derived from the current value of the corresponding attributes. These offset attributes may be changed programmatically via SSV instructions which, when used in

conjunction with future Function Block programs, provides custom "outer" control loop capability.

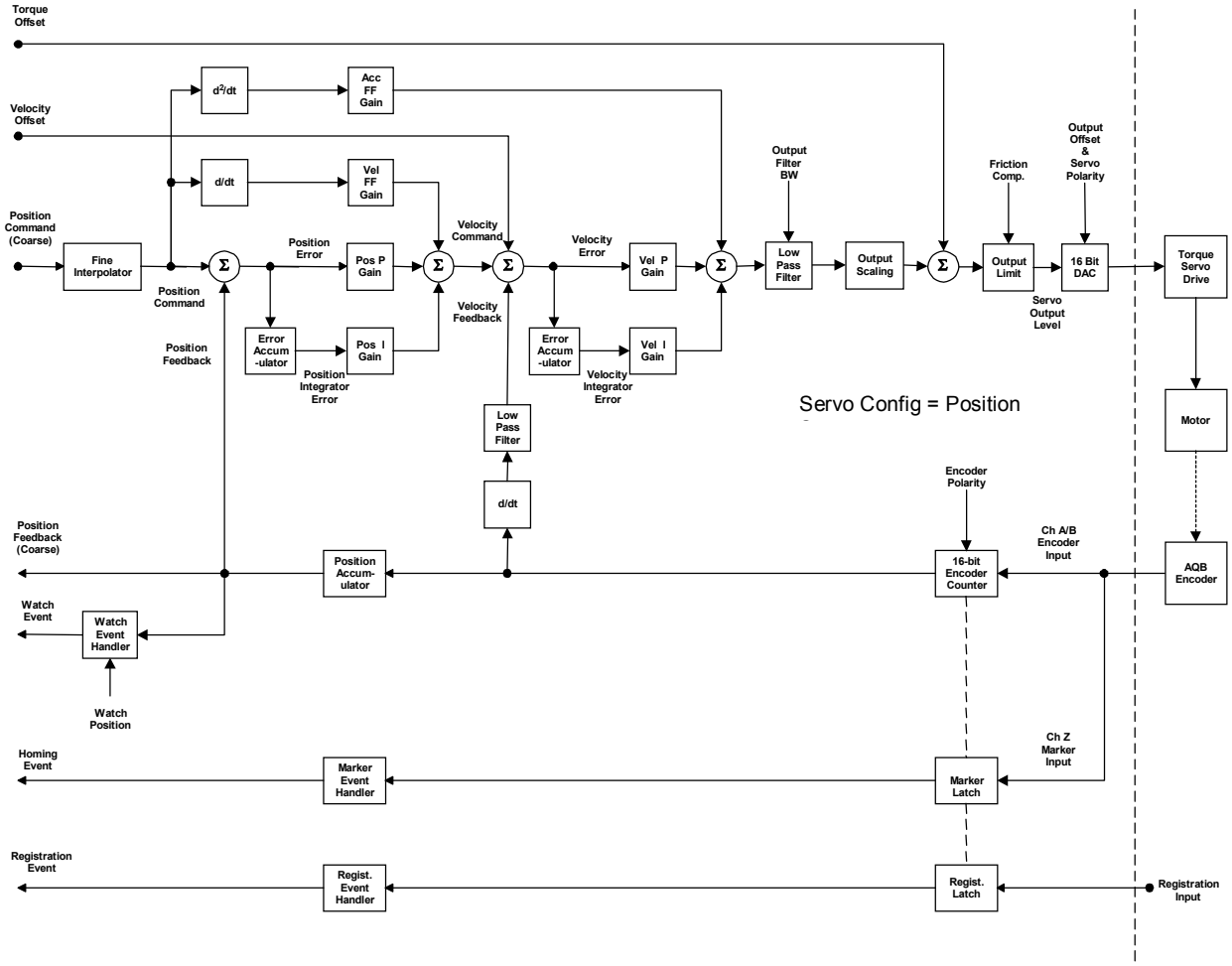


Figure 13.8 Position Servo with Torque Servo Drive

Position Servo with Velocity Servo Drive

This configuration provides full position servo control using an external velocity loop servo drive. Note that in this configuration the servo module does not close the velocity loop, but rather the drive does. Synchronous input data to the servo loop includes Position Command and Velocity Offset. (Torque Offset is ignored.) These values are updated at the coarse update rate of the associated motion group. The Position Command value is derived directly from the output of the motion planner, while the Velocity Offset value is derived from the current value of the corresponding attributes. The Velocity Offset attribute can be changed programmatically via SSV

instructions which, when used in conjunction with future Function Block programs, provides custom “outer” control loop capability.

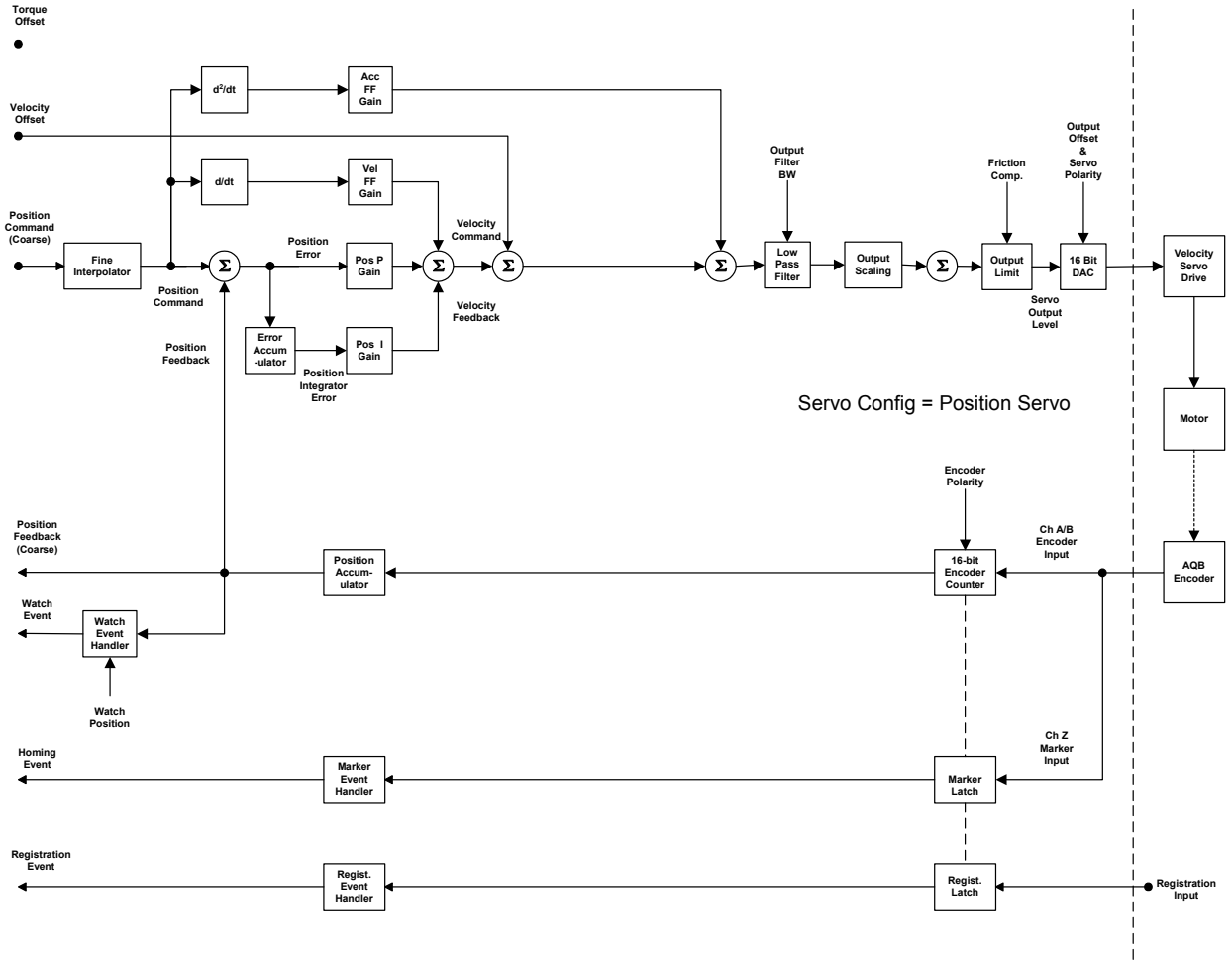


Figure 13.9 Position Servo with Velocity Servo Drive

Servo Gains

The 1756-M02AE 2-Axis Servo module uses a Nested Digital Servo Control Loop consisting of a position loop with proportional, integral and feed-forward gains around an optional digitally synthesized inner velocity loop, again with proportional and integral gains for each axis. These gains provide software control over the servo dynamics, and allow the servo system to be completely stabilized. Unlike analog servo controllers, these digitally set gains do not drift. Furthermore, once these gains are set for a particular system, another servo module

programmed with these gain values operates identically to the original one.

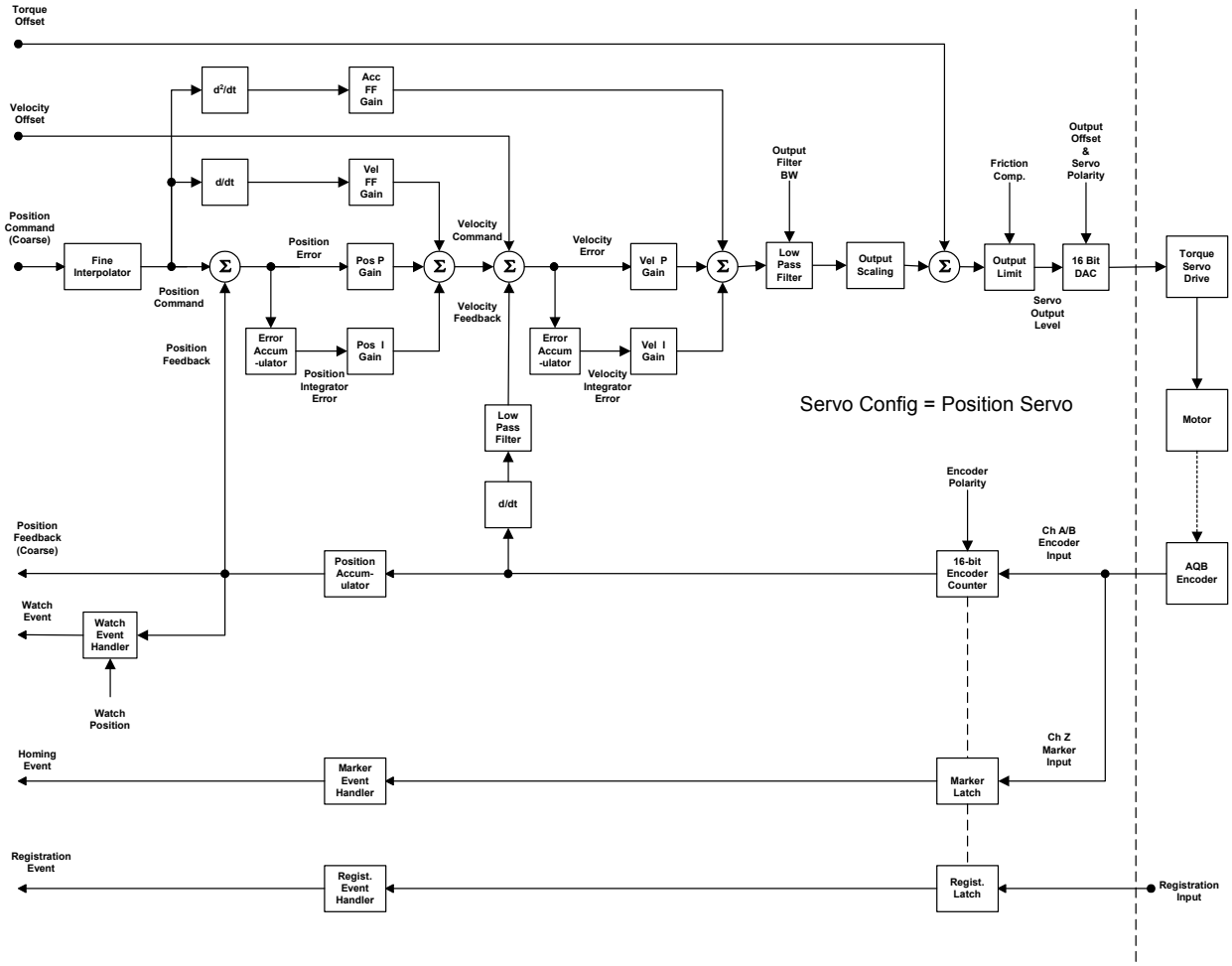


Figure 13.10 Servo Gains

Velocity Feedforward Gain

Servo Drives require non-zero command input to generate steady-state axis acceleration or velocity. To provide the non-zero output from the Servo Module a non-zero position or velocity error needs to be present. We call this dynamic error while moving "following error". Well, this non-zero following error condition is a situation are trying to avoid. We ideally want zero following error -- all the time. This could be achieved through use of the position integral gain controls as described above, but typically the response time of the integrator action is too slow to be effective. An alternative approach that has superior dynamic response is to use Velocity and Acceleration Feedforward.

The Velocity Feedforward Gain attribute is used to provide the Velocity Command output necessary to generate the commanded

velocity. It does this by scaling the current Command Velocity by the Velocity Feedforward Gain and adding it as an offset to the Velocity Command generated by the position loop control elements. With this done, the position loop control elements do not need to generate much of a contribution to the Velocity Command, hence the Position Error value is significantly reduced. Hence, the Velocity Feedforward Gain allows the following error of the servo system to be reduced to nearly zero when running at a constant speed. This is important in applications such as electronic gearing and synchronization applications where it is necessary that the actual axis position not significantly lag behind the commanded position at any time.

The optimal value for Velocity Feedforward Gain is 100% theoretically. In reality, however, the value may need to be tweaked to accommodate velocity loops with non-infinite loop gain and other application considerations. One thing that may force a smaller Velocity Feedforward value is that increasing amounts of feedforward tends to exacerbate axis overshoot. If necessary, the Velocity Feedforward Gain may be "tweaked" from the 100% value by running a simple user program that jogs the axis in the positive direction and monitor the Position Error of the axis during the jog. Increase the Velocity Feedforward Gain until the Position Error at constant speed is as small as possible, but still positive. If the Position Error at constant speed is negative, the actual position of the axis is *ahead* of the command position. If this occurs, decrease the Velocity Feedforward Gain such that the Position Error is again positive. Note that reasonable maximum velocity, acceleration, and deceleration values must be entered to jog the axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Feedforward Gain	REAL	%

Acceleration Feedforward Gain

When interfacing to an external torque servo drive, the Acceleration Feedforward Gain attribute is used to provide the Torque Command output necessary to generate the commanded acceleration. It does this by scaling the current Command Acceleration by the Acceleration Feedforward Gain and adding it as an offset to the Servo Output generated by the servo loop. With this done, the servo loops do not need to generate much of a contribution to the Servo Output, hence the Position and/or Velocity Error values are significantly reduced. Hence, when used in conjunction with the Velocity Feedforward Gain, the Acceleration Feedforward Gain allows the following error of the servo system during the acceleration and deceleration phases of motion to be reduced to nearly zero. This is important in applications such as electronic gearing and synchronization applications where it is necessary that the actual axis position not significantly lag behind the commanded position at any time.

When interfacing with an external velocity servo drive, Acceleration Feedforward can used to add a term to the Velocity Command that is proportional to the commanded acceleration. This can be effective in cases where the external drive exhibits a steady-state velocity error during acceleration and deceleration.

The optimal value for Acceleration Feedforward depends on the specific drive configuration. Excessive Acceleration Feedforward values tend to produce axis overshoot. For external torque servo drive applications the optimal value for Acceleration Feedforward is theoretically 100%. In reality, however, the value may need to be increased slightly to accommodate servo loops with non-infinite loop gain and other application considerations. For external velocity servo drive applications the optimal value for Acceleration Feedforward is highly dependent on the drive's speed scaling and servo loop configuration. A value of 100%, in this case, means only that 100% of the commanded acceleration value is applied to the velocity command summing junction and may not be even close to the optimal value.

If necessary, the Acceleration Feedforward Gain may be optimized by running a simple user program that jogs the axis in the positive direction and monitors the Position Error of the axis during the jog. Usually Acceleration Feedforward is used in tandem with Velocity Feedforward to achieve near zero following error during the entire motion profile. To fine tune the Acceleration Feedforward Gain, the Velocity Feedforward Gain must first be optimized using the procedure described above. While capturing the peak Position Error during the acceleration phase of the jog profile, increase the Acceleration Feedforward Gain until the peak Position Error is as small as possible, but still positive. If the peak Position Error during the acceleration ramp is negative, the actual position of the axis is *ahead* of the command position during the acceleration ramp. If this occurs, decrease the Acceleration Feedforward Gain such that the Position Error is again positive. To be thorough the same procedure should be done for the deceleration ramp to verify that the peak Position Error during deceleration is acceptable. Note that reasonable maximum velocity, acceleration, and deceleration values must be entered to jog the axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Acceleration Feedforward Gain	REAL	%

Position Proportional Gain

The Position Error is multiplied by the Position Proportional Gain, or Pos P Gain, to produce a component to the Velocity Command that ultimately attempts to correct for the position error. Increasing this gain value increases the bandwidth of the position servo loop and results in greater "static stiffness" of the axis which is a measure of the

corrective force that is applied to an axis for a given position error. Too little Pos P Gain results in excessively compliant, or mushy, axis behavior. Too large a Pos P Gain, on the other hand, can result in axis oscillation due to classical servo instability.

A well-tuned system moves and stops quickly or "smartly" and exhibits little or no "ringing" during constant velocity or when the axis stops. If the response time is poor, or the motion "sloppy" or slow, the proportional gain may need to be increased. If excessive ringing or overshoot is observed when the motor stops, the proportional gain may need to be decreased.

While the Pos P Gain is typically established by the automatic servo tuning procedure, the Pos P gain may also be set manually. Before doing this it must be stressed that the Output Scaling factor for the axis must be established for the drive system. Refer to Output Scaling attribute description for an explanation of how the Output Scaling factor can be calculated. Once this is done the Pos P Gain can be computed based on either the desired loop gain or the desired bandwidth of the position servo system.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Proportional Gain	REAL	1/Sec

Loop Gain Method

If you know the desired loop gain in Inches per Minute per mil or millimeters per minute per mil, use the following formula to calculate the corresponding P gain.

Pos P Gain = 16.667 * Desired Loop Gain (IPM/mil)

Thus, according to an old machine tool rule of thumb, a loop gain of 1 IPM/mil (Pos P gain = 16.7 Sec^{-1}) provides stable positioning for virtually any axis. In general, however, modern position servo systems typically run much tighter than this. The typical value for the Position Proportional Gain is ~100 Sec^{-1}.

Bandwidth Method

If you know the desired unity gain bandwidth of the position servo in Hertz, use the following formula to calculate the corresponding P gain.

Pos P Gain = Bandwidth (Hertz) / 6.28

In general, however, modern position servo systems typically run with at least a unity gain bandwidth of ~16 Hertz. The typical value for the Position Proportional Gain is ~100 Sec^{-1}.

Maximum Bandwidth

There are limitations to the maximum bandwidth that can be achieved for the position loop based on the dynamics of the inner velocity and torque loops of the system and the desired damping of the system, Z. These limitations may be expressed as follows:

$$\text{Bandwidth (Pos)} = 0.25 * 1/Z^2 * \text{Bandwidth (Vel)} = 0.25 * 1/Z^2 * \text{Bandwidth (Torque)}$$

For example, if the bandwidth of the drive's torque loop is 100 Hz and the damping factor, Z, is 0.8, the velocity bandwidth is approximately 40 Hz and the position bandwidth is 16 Hz. Based on these numbers the corresponding proportional gains for the loops can be computed. Note that the bandwidth of the torque loop includes feedback sampling delay and filter time constant.

Position Integral Gain

Position Integral Gain, or Pos I Gain, improves the steady-state positioning performance of the system. By using Position Integral Gain, it is possible to achieve accurate axis positioning despite the presence of such disturbances as static friction or gravity. Increasing the integral gain generally increases the ultimate positioning accuracy of the system. Excessive integral gain, however, results in system instability.

Every servo update the current Position Error is accumulated in variable called the Position Integral Error. This value is multiplied by the Position Integral Gain to produce a component to the Velocity Command that attempts to correct for the position error. The characteristic of Pos I Gain correction, however, is that any non-zero Position Error accumulates in time to generate enough force to make the correction. This attribute of Pos I Gain makes it invaluable in applications where positioning accuracy or tracking accuracy is critical. The higher the Pos I Gain value the faster the axis is driven to the zero Position Error condition. Unfortunately, Pos I Gain control is intrinsically unstable. Too much Pos I Gain results in axis oscillation and servo instability.

If the axis is configured for an external velocity loop servo drive, the Pos I Gain should be zero–most analog velocity loop servo amplifiers have integral gain of their own and do not tolerate *any* amount of Pos I Gain in the position loop without producing severe oscillations. If Pos I Gain is necessary for the application, the velocity integrator in the drive must be disabled.

In certain cases, Pos I Gain control is disabled. One such case is when the servo output to the axis' drive is saturated. Continuing integral control behavior in this case would only exacerbate the situation. Another common case is when performing certain motion. -. When the Integrator Hold Enable attribute is set, the servo loop automatically disables the integrator during commanded motion.

While the Pos I Gain, if employed, is typically established by the automatic servo tuning procedure, the Pos I Gain value may also be set manually. Before doing this it must be stressed that the Output Scaling factor for the axis must be established for the drive system. Refer to Output Scaling attribute description for an explanation of how the Output Scaling factor can be calculated. Once this is done the Pos I Gain can be computed based on the current or computed value for the Pos P Gain using the following formula:

$$\text{Pos I Gain} = 0.25 * 0.001 \text{ Sec/mSec} * (\text{Pos P Gain})^2$$

Assuming a Pos P Gain value of 100 Sec^{-1} this results in a Pos I Gain value of 2.5 ~0.1 $mSec^{-1}$-Sec^{-1}

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Integral Gain	REAL	1/mSec-Sec

Velocity Proportional Gain

When configured for a torque (current) loop servo drive, the servo module's digital velocity loop provides damping without the requirement for an analog tachometer. The Velocity Error is multiplied by the Velocity Proportional Gain to produce a component to the Servo Output or Torque Command that ultimately attempts to correct for the velocity error, creating the damping effect. Thus, increasing the Velocity Proportional Gain results in smoother motion, enhanced acceleration, reduced overshoot, and greater system stability. The velocity loop also allows higher effective position loop gain values to be used, however, too much Velocity Proportional Gain leads to high frequency instability and resonance effects. Note that units for Velocity Proportional Gain are identical to that of the Position Proportional Gain making it easy to perform classic inches/min/mil calculations to determine static stiffness or damping.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Proportional Gain	REAL	1/Sec

Maximum Bandwidth

There are limitations to the maximum bandwidth that can be achieved for the velocity loop based on the dynamics of the torque loop of the servo drive and the desired damping of the system, Z. These limitations may be expressed as follows:

$$\text{Bandwidth (Velocity)} = 0.25 * 1/Z^2 * \text{Bandwidth (Torque)}$$

For example, if the bandwidth of the drive's torque loop is 100 Hz and the damping factor, Z, is 0.8, the velocity bandwidth is approximately 40 Hz. Based on this number the corresponding gains for the loop can be computed. Note that the bandwidth of the torque loop includes feedback sampling delay and filter time constant.

The velocity loop in the motion controller is not used when the servo module is configured for a velocity loop servo drive, Thus, establishing the Velocity Proportional Gain is not required in this case.

The typical value for the Velocity Proportional Gain is ~250 Sec^{-1}.

Velocity Integral Gain

When configured for a torque (current) loop servo drive, every servo update the current Velocity Error is also accumulated in variable called the Velocity Integral Error. This value is multiplied by the Velocity Integral Gain to produce a component to the Servo Output or Torque Command that attempts to correct for the velocity error. The characteristic of Vel I Gain correction, however, is that any non-zero Velocity Error accumulates in time to generate enough force to make the correction. This attribute of Vel I Gain makes it invaluable in applications where velocity accuracy is critical. The higher the Vel I Gain value the faster the axis is driven to the zero Velocity Error condition. Unfortunately, I Gain control is intrinsically unstable. Too much I Gain results in axis oscillation and servo instability.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Integral Gain	REAL	1/mSec-Sec

In certain cases, Vel I Gain control is disabled. One such case is when the servo output to the axis' drive is saturated. Continuing integral control behavior in this case would only exacerbate the situation. Another common case is when performing certain motion. When the Integrator Hold Enable attribute is set, the servo loop automatically disables the integrator during commanded motion.

Due to the destabilizing nature of Integral Gain, it is recommended that Position Integral Gain and Velocity Integral Gain be considered

mutually exclusive. If Integral Gain is needed for the application use one or the other, but not both. In general, where static positioning accuracy is required, Velocity Integral Gain is the better choice.

The typical value for the Velocity Integral Gain is ~15 $mSec^{-1}$-Sec^{-1}.

Position Differential Gain

In some External Velocity Servo Drive applications where the level of damping provided by the external drive is insufficient for good position servo loop performance, additional damping may be achieved via the Position Loop Differential Gain. Assuming a non-zero Position Loop Differential Gain value, the difference between the current Position Error value and the last Position Error value is computed. This value is then multiplied by the Position Loop Differential Gain to produce a component to the Servo Output or Velocity Command that attempts to correct for the change in position error, creating a “damping” effect. Increasing this gain value results in greater “damping” of the axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Differential Gain	REAL	

Velocity Scaling

The Velocity Scaling attribute is used to convert the output of the servo loop into equivalent voltage to an external velocity servo drive. This has the effect of “normalizing” the units of the servo loop gain parameters so that their values are not affected by variations in feedback resolution, drive scaling, or mechanical gear ratios. The Velocity Scaling value is typically established by servo’s automatic tuning procedure but these values can be calculated if necessary using the following guidelines.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Scaling	REAL	% / Position Units Per Second

If the axis is using a velocity servo drive, the software velocity loop in the servo module is disabled. In this case the Velocity Scaling value can be calculated by the following formula:

Velocity Scaling = 100% / (Speed @ 100%)

For example, if this axis is using position units of motor revolutions (revs), and the servo drive is scaled such that with an input of 100% (e.g. 10 Volts) the motor goes 5,000 RPM (or 83.3 RPS), the Torque Scaling attribute value would be calculated as shown below.

Velocity Scaling = 100% / (83.3 RPS) = 1.2% / Revs Per Second

Torque Scaling

The Torque Scaling attribute is used to convert the acceleration of the servo loop into equivalent% rated torque to the motor. This has the effect of "normalizing" the units of the servo loops gain parameters so that their values are not affected by variations in feedback resolution, drive scaling, motor and load inertia, and mechanical gear ratios. In fact, the Torque Scaling value, when properly established, represents the inertia of the system and is related to the Tune Inertia attribute value by a factor of the Conversion Constant. The Torque Scaling value is typically established by the MAAT instruction as part of the controller's automatic tuning procedure but the value can be manually calculated, if necessary, using the following guidelines.

Torque Scaling = 100% Rated Torque / (Acceleration @ 100% Rated Torque)

For example, if this axis is using position units of motor revolutions (revs), and that with 100% rated torque applied to the motor, the motor accelerates at a rate of 3000 Revs/Sec^2, the Torque Scaling attribute value would be calculated as shown below.

Torque Scaling = 100% Rated / (3000 RPS^2) = 0.0333% Rated/ Revs Per Second^2

Note that if the Torque Scaling value does not reflect the true torque to acceleration characteristic of the system, the gains also do not reflect the true performance of the system.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Torque Scaling	REAL	% / Position Units Per Second^2

Directional Scaling Ratio

In some cases, the speed or velocity scaling of the external drive actuator may be directionally dependent. This non-linearity can be substantial in hydraulic applications. To compensate for this behavior, the Directional Scaling Ratio attribute can be applied to the Output Scaling based on the sign of the Servo Output. Specifically, the Output Scaling value is scaled by the Directional Scaling Ratio when the sign of the Servo Output is positive. Thus, the Directional Scaling Ratio is the ratio of the Output Scaling in the positive direction (positive servo output) to the Output Scaling in the negative direction (negative servo output). The value for the Directional Scaling ratio can be empirically determined by running the auto-tune procedure in the positive direction and then in the negative direction and calculating the ratio of the resulting Velocity/Torque Scaling values.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Directional Scaling Ratio	REAL	

Backlash Reversal Error

Backlash Reversal Error provides the user the capability to compensate for positional inaccuracy introduced by mechanical backlash. For example, power-train type applications require a high level of accuracy and repeatability during machining operations. Axis motion is often generated by a number of mechanical components, a motor, a gearbox, and a ball-screw that may introduce inaccuracies and that are subject to wear over their lifetime. Hence, when an axis is commanded to reverse direction, mechanical play in the machine (through the gearing, ball-screw, etc.) may result in a small amount of motor motion without axis motion. As a result, the feedback device may indicate movement even though the axis has not physically moved.

Compensation for mechanical backlash can be achieved by adding a directional offset, specified by the Backlash Reversal Error attribute, to the motion planner's command position as it is applied to the associated servo loop. Whenever the commanded velocity changes sign (a reversal), the Logix controller adds, or subtracts, the Backlash Distance value from the current commanded position. This causes the servo to immediately move the motor to the other side of the backlash window and engage the load. It is important to note that the application of this directional offset is completely transparent to the user; the offset does not have any affect on the value of the Command Position attribute.

If a value of zero is applied to the Backlash Reversal Offset, the feature is effectively disabled. Once enabled by a non-zero value, and the load is engaged by a reversal of the commanded motion, changing the Backlash Reversal Offset can cause the axis to shift as the offset correction is applied to the command position..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Backlash Reversal Error	REAL	

Backlash Stabilization Window

The Backlash Stabilization Window attribute is used to control the Backlash Stabilization feature in the servo control loop. What follows is a description of this feature and the general backlash instability phenomenon..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Backlash Stabilization Window	REAL	

Mechanical backlash is a common problem in applications that utilize mechanical gearboxes. The problem stems from the fact that until the input gear is turned to the point where its proximal tooth contacts an adjacent tooth of the output gear, the reflected inertia of the output is

not felt at the motor. In other words, when the gear teeth are not engaged, the system inertia is reduced to the motor inertia.

If the servo loop is tuned for peak performance with the load applied, the axis is at best under-damped and at worst unstable in the condition where the gear teeth are not engaged. In the worst case scenario, the motor axis and the input gear oscillates wildly between the limits imposed by the output gear teeth. The net effect is a loud buzzing sound when the axis is at rest. If this situation persists the gearbox wears out prematurely. To prevent this condition, the conventional approach is to de-tune the servo so that the axis is stable without the gearbox load applied. Unfortunately, system performance suffers."

Due to its non-linear, discontinuous nature, adaptive tuning algorithms generally fall short of addressing the backlash problem. However, a very effective backlash compensation algorithm can be demonstrated using the Torque Scaling gain. The key to this algorithm is the tapered Torque Scaling profile, shown below, as a function of the position error of the servo loop. The reason for the tapered profile, as opposed to a step profile, is that when the position error exceeds the backlash distance a step profile would create a very large discontinuity in the torque output. This repulsing torque tends to slam the axis back against the opposite gear tooth and perpetuate the buzzing effect. The profile below is only run when the acceleration command to the servo loop is zero, i.e. when we are not commanding any acceleration or deceleration that would engage the teeth of the gearbox.

Properly configured with a suitable value for the Backlash Stabilization Window, this algorithm entirely eliminates the gearbox buzz without sacrificing any servo performance. The Backlash Stabilization parameter determines the width of the window over which backlash stabilization is applied. In general, this value should be set to the measured backlash distance. A Backlash Stabilization Window value of zero effectively disables the feature. (Patent Pending)

Output LP Filter Bandwidth

The Output Filter Bandwidth attribute controls the bandwidth of the servo's low-pass digital output filter. The programmable low-pass output filter is bypassed if the configured Output Filter Bandwidth for this filter is set to zero (the default). This output filter can be used to filter out, or reduce, high frequency variation of the servo module output to the drive. The lower the Output Filter Bandwidth, the greater the attenuation of these high frequency components of the output signal. Unfortunately, since the low-pass filter adds lag to the servo loop which pushes the system towards instability, decreasing

the Output Filter Bandwidth usually requires lowering the Position or Velocity Proportional Gain of the system to maintain stability.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Output LP Filter Bandwidth	REAL	Hertz

The output filter is particularly useful in high inertia applications where resonance behavior can severely restrict the maximum bandwidth capability of the servo loop.

Integrator Hold Enable

When the Integrator Hold Enable attribute value is configured TRUE, the servo loop temporarily disables any enabled integrators while the command position is changing. This feature is used by point-to-point moves to minimize the integrator wind-up during motion. When the Integrator Hold Enable attribute value is FALSE, all active integrators are always enabled.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Integrator Hold Enable	SINT	

Servo Limits

This section covers the various servo attributes that either apply limits to various servo loop real-time parameters, such as position and output voltage, or are used in limit checks of servo loop parameters like position error.

Maximum Positive/Negative Travel

The Axis Object provides configurable software travel limits via the Maximum Positive and Negative Travel attributes. If the axis is configured for software overtravel limit checking by setting the Soft Overtravel Bit in the Servo Configuration Bit word, and the axis passes outside these maximum travel limits, a Software Overtravel Fault is issued.

When software overtravel checking is enabled, appropriate values for the maximum travel in both the Maximum Positive and Maximum Negative Travel attributes need to be established with Maximum Positive Travel always greater than Maximum Negative Travel. Both of these values are specified in the configured Position Units of the axis.

Note: The software travel limits are not enabled until the selected homing sequence is completed.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Maximum Positive Travel	REAL	Position Units
SSV/GSV	Maximum Negative Travel	REAL	Position Units

Position Error Tolerance

The Position Error Tolerance parameter specifies how much position error the servo tolerates before issuing a Position Error Fault. Like the position lock tolerance, the position error tolerance is interpreted as a ± quantity. For example, specifying a position error tolerance of 0.75 Position Units means that a Position Error Fault is generated whenever the position error of the axis is greater than 0.75 or less than -0.75 Position Units, as shown below:

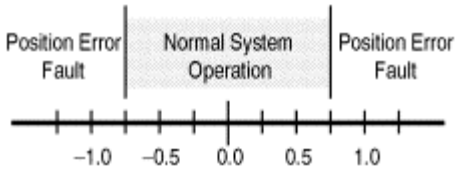


Figure 13.11 Position Error

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Error Tolerance	REAL	Position Units

The self tuning routine sets the position error tolerance to twice the following error at maximum speed based on the measured response of the axis. In most applications, this value provides reasonable protection in case of an axis fault or stall condition without nuisance faults during normal operation. If you need to change the calculated position error tolerance value, the recommended setting is 150% to 200% of the position error while the axis is running at its maximum speed.

Position Lock Tolerance

The Position Lock Tolerance attribute value specifies how much position error the servo module tolerates when giving a true Position Locked Status indication. When used in conjunction with the Position Locked Status bit, it is a useful parameter to control positioning accuracy. The Position Lock Tolerance value should be set, in Position Units, to the desired positioning accuracy of the axis.

Note that the position lock tolerance value is interpreted as a ± quantity. For example, if your position units are Inches, specifying a position lock tolerance of 0.01 provides a minimum positioning accuracy of ±0.01 inches as shown below.

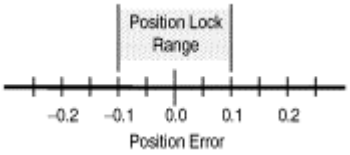


Figure 13.12 Position Lock

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Lock Tolerance	REAL	Position Units

Output Limit The Output Limit attribute provides a method of limiting the maximum servo output voltage of a physical axis to a specified level. The servo output for the axis as a function of position servo error, both with and without servo output limiting, is shown below.

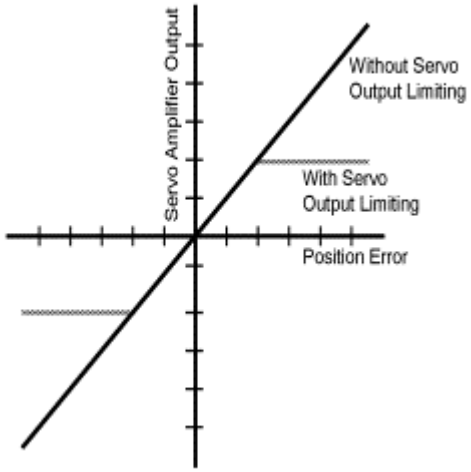


Figure 13.13 Servo Output Limit

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Output Limit	REAL	Volts Range: 0.0 - 10.0

The servo output limit may be used as a software current or torque limit if you are using a servo drive in torque (current) loop mode. The percentage of the drive's maximum current that the servo controller commands is equal to the specified servo output limit. For example, if the drive is capable of 30 Amps of current for a 10 Volt input, setting

the servo output limit to 5V limits the maximum drive current to 15 Amps.

The servo output limit may also be used if the drive cannot accept the full ±10 Volt range of the servo output. In this case, the servo output limit value effectively limits the maximum command sent to the amplifier. For example, if the drive can only accept command signals up to ±7.5 Volts, set the servo output limit value to 7.5 volts.

Direct Drive Ramp Rate

The Direct Drive Ramp Rate attribute contains a slew rate for changing the output voltage when the Direct Drive On (MDO) instruction is executed. A Direct Drive Ramp Rate of 0, disables the output ramp rate limiter, allowing the Direct Drive On voltage to be applied directly.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Direct Drive Ramp Rate	REAL	Volts/Second

Servo Offsets

This section covers the various servo attributes that provide offsets to real-time servo loop operation.

Friction Compensation

It is not unusual for an axis to have enough static friction, so called "sticktion", that even with a significant position error, refuses to budge. Of coarse, integral gain can be used to generate enough output to the drive to correct the error, but this approach may not be responsive enough for the application. An alternative is to use Friction Compensation to break sticktion in the presence of a non-zero position error. This is done by adding, or subtracting, a fixed output level, called Friction Compensation, to the Servo Output value based on its current sign.

The Friction Compensation value should be just under the value that would break the sticktion. A larger value results in the Axis to "dither", a phenomena describing a rapid back and forth motion of the axis centered on the commanded position.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Friction Compensation	REAL	% Range: - 0% to 100%

Friction Compensation Window

To address the issue of dither when applying Friction Compensation and hunting from the integral gain, a Friction Compensation Window is applied around the current command position when the axis is not

being commanded to move. If the actual position is within the Friction Compensation Window the Friction Compensation value is applied to the Servo Output but scaled by the ratio of the position error to the Friction Compensation Window. Within the window, the servo integrators are also disabled. Thus, once the position error reaches or exceeds the value of the Friction Compensation Window attribute, the full Friction Compensation value is applied. Of course, should the Friction Compensation Window be set to zero, this feature is effectively disabled.

A non-zero Friction Compensation Window has the effect of softening the Friction Compensation as its applied to the Servo Output and reducing the dithering effect that it can create. This generally allows higher values of Friction Compensation to be applied. Hunting is also eliminated at the cost of a small steady-state error.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Friction Compensation Window	REAL	Position Units

Velocity Offset Velocity Offset compensation can be used to correct to provide a dynamic velocity correction to the output of the position servo loop. Since this value is updated synchronously every Coarse Update Period, the Velocity Offset can be tied into custom outer control loop algorithms using Function Block programming.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Offset	REAL	Position Units per sec

Torque Offset Torque Offset compensation can be used to provide a dynamic torque command correction to the output of the velocity servo loop. Since this value is updated synchronously every Coarse Update Period, the Torque Offset can be tied into custom outer control loop algorithms using Function Block programming.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Torque Offset	REAL	% Range: -100% to 100%

Output Offset Another common situation when interfacing an external Servo Drive, particularly for velocity servo drives, is the effect of drive offset. Cumulative offsets of the servo module's DAC output and the Servo Drive Input result in a situation where a zero commanded Servo Output value causes the axis to "drift". If the drift is excessive it can play havoc on the Hookup Diagnostic and Tuning procedures as well

as result in a steady-state non-zero position error when the servo loop is closed.

Output offset compensation can be used to correct this problem by adding a fixed value, called Output Offset, to the Servo Output. This value is chosen to achieve near zero drive velocity when the uncompensated Servo Output value is zero.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Output Offset	REAL	Volts Range: +/-10

Servo Fault Configuration

Servo Fault Actions

Each axis can be configured to respond to each of the five types of servo faults in any one of four different ways. This flexibility is important because motion control applications differ widely in their fault action requirements..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Soft Overtravel Fault Action	SINT	Enumeration: 0 = shutdown 1 = disabled drive 2 = stop command 3 = status only
SSV/GSV	Hard Overtravel Fault Action	SINT	Enumeration: 0 = shutdown 1 = disabled drive 2 = stop command 3 = status only
SSV/GSV	Position Error Fault Action	SINT	Enumeration: 0 = shutdown 1 = disabled drive 2 = stop command 3 = status only

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Feedback Fault Action	SINT	Enumeration: 0 = shutdown 1 = disabled drive 2 = stop command 3 = status only
SSV/GSV	Feedback Noise Fault Action	SINT	Enumeration: 0 = shutdown 1 = disabled drive 2 = stop command 3 = status only
SSV/GSV	Drive Fault Action	SINT	Enumeration: 0 = shutdown 1 = disabled drive 2 = stop command 3 = status only

Shutdown

If a fault action is set to Disable Drive, then when the associated fault occurs, axis servo action is immediately disabled, the servo amplifier output is zeroed, and the appropriate drive enable output is deactivated. Furthermore, this fault action opens the OK contact associated with the servo module which can be used to open the E-Stop string to the drive power supply. Shutdown is the most severe action to a fault and it is usually reserved for faults which could endanger the machine or the operator if power is not removed as quickly and completely as possible.

Disable Drive

If a fault action is set to Disable Drive, then when the associated fault occurs, axis servo action is immediately disabled, the servo amplifier output is zeroed, and the appropriate drive enable output is deactivated. Shutdown is the most severe action to a fault and it is usually used for faults which could endanger the machine or the operator if power is not removed as quickly as possible.

Stop Command

If a fault action is set to Stop Command, then when the associated fault occurs, the axis immediately starts decelerating the axis command position to a stop at the configured Maximum Deceleration Rate without disabling servo action or the servo modules Drive Enable output. This is the gentlest stopping mechanism in response to a fault. It is usually used for less severe faults. Once the stop command fault action has stopped the axis, no further motion can be generated until the fault is first cleared.

Status Only

If a fault action is set to Status Only, then when the associated fault occurs, motion faults must be handled by the application program. In general, this setting should *only* be used in applications where the standard fault actions are not appropriate. The recommended setting of the fault action configuration parameters–suitable for most applications–are provided as defaults.

When setting a fault action of Stop Command or Status Only, the drive must remain enabled for the Logix controller to continue to control the axis. For example, in the case of Stop Command it is not possible for the Logix controller to bring the axis to a controlled stop when the axis is already disabled due to a drive fault. Similarly, selecting Status Only only allows motion to continue if the drive itself is still enabled and tracking the command reference.

Commissioning Configuration Attributes

The Axis Object provides sophisticated automatic test tuning instructions, which allow it to determine proper settings for the servo loop attributes for each axis. These include not only the polarities, the gains, and also the maximum acceleration, deceleration, and velocity parameters.

Usually, the servo loop parameters need only be tested and tuned once when the motion controller is first integrated into the machine or when the machine is being commissioned at start-up. However, if the load on any axis changes significantly or if the motor or servo amplifier is replaced for any reason, it may be necessary to re-test and re-tune the servo loop parameters.

The Commissioning Configuration Attributes shown in the table below are used to control the axis test and tuning processes that are initiated by the MRHD and MRAT instructions. Therefore, these values should be established before the MRHD or MRAT instructions are executed.

Test Increment

The Motor Feedback Test Increment attribute is used in conjunction with the MRHD (Motion Run Hookup Diagnostic) instruction to determine the amount of motion that is necessary to satisfy the MRHD initiated test process. This value is typically set to approximately a quarter of a revolution of the motor..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Test Increment	REAL	Position Units

Tuning Travel Limit The Tuning Travel Limit attribute is used in conjunction with the MRAT (Motion Run Axis Tuning) instruction to limit the excursion of the axis during the test. If, while performing the tuning motion profile, the servo module determines that the axis is not able to complete the tuning process before exceeding the Tuning Travel Limit, the servo module terminates the tuning profile and report that the Tuning Travel Limit was exceeded via the Tune Status attribute. This does not mean that the Tuning Travel Limit was actually exceeded, but that had the tuning process gone to completion that the limit would have been exceeded..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Tuning Travel Limit	REAL	Position Units

The Tuning Travel Limit attribute is used in conjunction with the MRAT (Motion Run Axis Tuning) instruction to limit the excursion of the axis during the test. If, while performing the tuning motion profile, the servo module determines that the axis is not be able to complete the tuning process before exceeding the Tuning Travel Limit, the servo module terminates the tuning profile and report that the Tuning Travel Limit was exceeded via the Tune Status attribute. This does not mean that the Tuning Travel Limit was actually exceeded, but that had the tuning process gone to completion that the limit would have been exceeded.

Tuning Speed The Tuning Speed attribute value determines the maximum speed of the MRAT (Motion Run Axis Tune) initiated tuning motion profile. This attribute should be set to the desired maximum operating speed of the motor prior to running the MRAT instruction. The reason for doing this is that the tuning procedure measures maximum acceleration and deceleration rates based on ramps to and from the Tuning Speed. Thus, the accuracy of the measured acceleration and deceleration capability is reduced by tuning at a speed other than the desired operating speed of the system..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Tuning Speed	REAL	Position Units / Sec

Tuning Torque The Tuning Torque attribute value determines the maximum torque of the MRAT (Motion Run Axis Tune) initiated tuning motion profile. This attribute should be set to the desired maximum safe torque level prior to running the MRAT instruction. The default value is 100%, which yields the most accurate measure of the acceleration and deceleration capabilities of the system. In some cases a lower tuning torque limit value may be desirable to limit the stress on the mechanics during the

tuning procedure. In this case the acceleration and deceleration capabilities of the system are extrapolated based on the ratio of the tuning torque to the maximum torque output of the system. Note that the extrapolation error increases as the Tuning Torque value decreases..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Tuning Torque	REAL	%

Damping Factor The Damping Factor attribute value is used in calculating the maximum Position Servo Bandwidth (see below) during execution of the MRAT (Motion Run Axis Tune) instruction. In general the Damping Factor attribute controls the dynamic response of the servo axis. When gains are tuned using a small damping factor (like 0.7), a step response test performed on the axis would demonstrate under-damped behavior with velocity overshoot. A gain set generated using a larger damping factor, like 1.0, would produce a system step response that have no overshoot but have a significantly lower servo bandwidth. The default value for the Damping Factor of 0.8 should work fine for most applications.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Damping Factor	REAL	

Drive Model Time Constant The value for the Drive Model Time Constant represents lumped model time constant for the drives current loop used by the MRAT instruction to calculate the Maximum Velocity and Position Servo Bandwidth values. The Drive Model Time Constant is the sum of the drive's current loop time constant, the feedback sample period, and the time constant associated with the velocity feedback filter. This value is set to a default value when the axis is configured based on the specific servo module selection. This value is only used by MRAT when the axis is configured for an External Torque Servo Drive..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Drive Model Time Constant	REAL	Sec

Velocity Servo Bandwidth The value for the Velocity Servo Bandwidth represents the unity gain bandwidth that is to be used to calculate the gains for a subsequent MAAT (Motion Apply Axis Tune) instruction. The unity gain bandwidth is the frequency beyond which the velocity servo is unable to provide any significant position disturbance correction. In general, within the constraints of a stable servo system, the higher the Velocity

Servo Bandwidth is the better the dynamic performance of the system. A maximum value for the Velocity Servo Bandwidth is generated by the MRAT (Motion Run Axis Tune) instruction. Computing gains based on this maximum value via the MAAT instruction results in dynamic response in keeping with the current value of the Damping Factor described above. Alternatively, the responsiveness of the system can be "softened" by reducing the value of the Velocity Servo Bandwidth before executing the MAAT instruction..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Servo Bandwidth	REAL	Hertz

There are practical limitations to the maximum Velocity Servo Bandwidth for the velocity servo loop based on the drive system and, in some cases, the desired damping factor of the system, Z. Exceeding these limits could result in an unstable servo operation. These bandwidth limitations may be expressed as follows:

For an external velocity loop servo drive,

Max Velocity Servo Bandwidth (Hz) = 0.159 * 2/Tune Rise Time

For an external torque loop servo drive,

Max Velocity Servo Bandwidth (Hz) = 0.159 * 0.25 * $1/Z^2$ * 1/Drive Model Time Constant

The factor of 0.159 represents the 1/2PI factor required to convert Radians per Second units to Hertz.

Position Servo Bandwidth

The value for the Position Servo Bandwidth represents the unity gain bandwidth that is to be used to calculate the gains for a subsequent MAAT (Motion Apply Axis Tune) instruction. The unity gain bandwidth is the frequency beyond which the position servo is unable to provide any significant position disturbance correction. In general, within the constraints of a stable servo system, the higher the Position Servo Bandwidth is the better the dynamic performance of the system. A maximum value for the Position Servo Bandwidth is generated by the MRAT (Motion Run Axis Tune) instruction. Computing gains based on this maximum value via the MAAT instruction results in dynamic response in keeping with the current value of the Damping Factor described above. Alternatively, the responsiveness of the system can

be “softened” by reducing the value of the Position Servo Bandwidth before executing the MAAT instruction..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Servo Bandwidth	REAL	Hertz

There are limitations to the maximum bandwidth that can be achieved for the position loop based on the dynamics of the inner velocity and current loops of the servo system and the desired damping of the system, Z. Exceeding these limits could result in an unstable system. These bandwidth limitations may be expressed as follows:

$$\text{Max Position Bandwidth (Hz)} = 0.25 * 1/Z^2 * \text{Velocity Bandwidth (Hz)}$$

For example, if the maximum bandwidth of the velocity servo loop is 40 Hz and the damping factor, Z, is 0.8, the maximum the maximum position bandwidth is 16 Hz. Based on these numbers the corresponding proportional gains for the loops can be computed.

Tuning Configuration Bits

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Tuning Configuration Bits	DINT	0: Tuning Direction Reverse 1: Tune Position Error Integrator 2: Tune Velocity Error Integrator 3: Tune Velocity Feedforward 4: Tune Acceleration Feedforward 5: Tune Output Low-Pass Filter 6: Bi-directional Tuning 7: Tune Friction Compensation 8: Tune Torque Offset 9-31: *Reserved*

Tuning Direction Reverse

The Tune Direction Reverse bit attribute determines the direction of the tuning motion profile initiated by the MRAT (Motion Run Axis Tune) instruction. If this bit is set (true), motion is initiated in the reverse (or negative) direction.

Tune Position Error Integrator

The Tune Position Error Integrator bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Position Integral Gain. If this bit is clear (false) the value for the Position Integral Gain is set to zero.

Tune Velocity Error Integrator

The Tune Velocity Error Integrator bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Velocity Integral Gain. If this bit is clear (false) the value for the Velocity Integral Gain is set to zero.

Tune Velocity Feedforward

The Tune Velocity Feedforward bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Velocity Feedforward Gain. If this bit is clear (false) the value for the Velocity Feedforward Gain is set to zero.

Tune Acceleration Feedforward

The Tune Acceleration Feedforward bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Acceleration Feedforward Gain. If this bit is clear (false) the value for the Acceleration Feedforward Gain is set to zero.

Tune Output Low-Pass Filter

The Tune Output Low-Pass Filter bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Output Filter Bandwidth. If this bit is clear (false) the value for the Output Filter Bandwidth is set to zero which disables the filter.

Bi-directional Tuning

The Bi-directional Tuning bit attribute determines the whether the tuning motion profile initiated by the MRAT (Motion Run Axis Tune) instruction is unidirectional or bi-directional. If this bit is set (true), the tuning motion profile is first initiated in specified tuning direction and then is repeated in the opposite direction. Information returned by the Bi-directional Tuning profile can be used to tune Friction Compensation and Torque Offset. When configured for a “hydraulics” External Drive Type the bi-directional tuning algorithm also computes the Directional Scaling Ratio.

Tune Friction Compensation

The Tune Friction Compensation bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Friction Compensation Gain. This tuning configuration is only valid if configured for bi-directional tuning. If this bit is clear (false) the value for the Friction Compensation Gain is not affected.

Tune Torque Offset

The Tune Torque Offset bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Torque Offset. This tuning configuration is only valid if configured for bi-directional tuning. If this bit is clear (false) the value for the Torque Offset is not affected.

Servo Drive Status Attributes

The following sections define in more detail the behavior of the various status attributes associated with the Servo Drive specific behavior of the Motion Axis Object. Status attributes are, by definition, read access only. The following Servo specific Status Attributes are divided into 3 categories: Drive Status attributes, Drive Commissioning Status attributes, and Drive Status Bit attributes.

Drive Status Attributes

The list of Drive Status Attributes associated with the Motion Axis Object provides access to servo drive resident information for the axis. These values may be used as part of the user program to perform real time measurements of drive operation. A list of all Drive Status Attributes is shown in the table below.

Since Drive Status Attributes values are resident in the drive, these values need to be transferred to the ControlLogix processor module on a regular basis. To avoid unnecessary communication traffic transferring data that is not of interest, it is necessary to explicitly activate transfer of the specific Drive Status Attribute data from the drive using the Axis Info Select attributes. Thus, a Servo Status Attribute value is **ONLY** valid if the attribute has been selected by one of the Axis Info Select attributes. Otherwise the Drive Status Attribute value is forced to zero.

In order for the above position unit-based attributes to return a meaningful value, the ‘Conversion Constant’ Axis Configuration Attribute must be established. Furthermore, attributes having velocity or acceleration units (e.g. Position Units / Sec) must also have a valid coarse update period which is established through association with a fully configured Motion Group Object.

Each of the Drive Status Attributes appears in the following Servo block diagram.

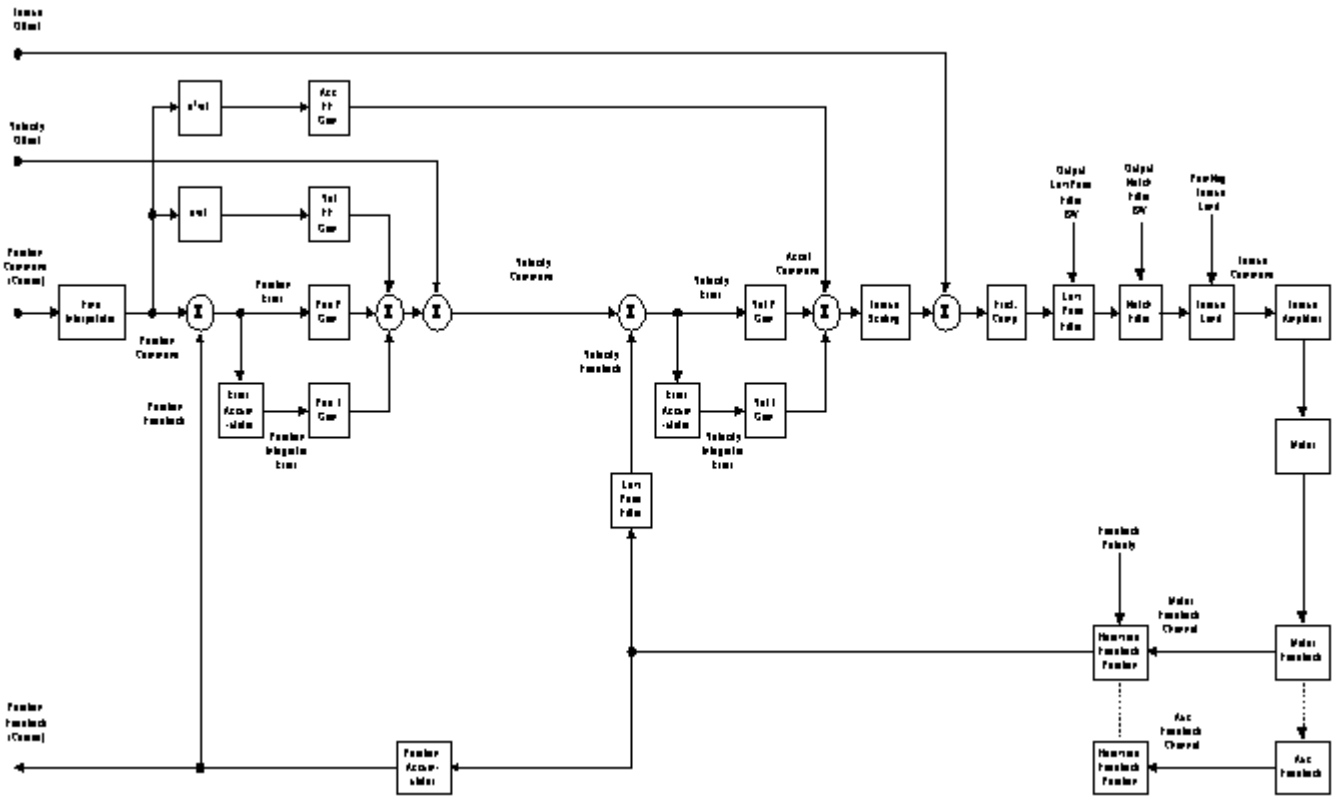


Figure 13.14 Motor Position Servo Loop Diagram

Position Command Position Command is the current value of the Fine Command Position into the position loop summing junction, in configured axis Position Units. Within the active servo loop, the Position Command value is used to control the position of the axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Command	REAL	Position Units

Position Feedback Position Feedback is the current value of the Fine Actual Position into the position loop summing junction, in configured axis Position Units. Within the servo loop, the Position Feedback represents the current position of the axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Feedback	REAL	Position Units

Aux Position Feedback Aux Position Feedback is the current value of the position feedback coming from the auxiliary feedback input. This value is not supported in the first release.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Aux Position Feedback	REAL	Position Units

Position Error Position Error is the difference, in configured axis Position Units, between the command and actual positions of a drive axis. For an axis with an active servo loop, position error is used, along with other error terms, to drive the motor to the condition where the actual position is equal to the command position..

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Error	REAL	Position Units

Position Integrator Error Position Integrator Error is the running sum of the Position Error, in the configured axis Position Units, for the specified axis. For an axis with an active servo loop, the position integrator error is used, along with other error terms, to drive the motor to the condition where the actual position is equal to the command position.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Integrator Error	REAL	Position Units - mSec

Velocity Error Velocity Error is the difference, in configured axis Position Units per Second, between the commanded and actual velocity of a drive axis. For an axis with an active velocity servo loop, velocity error is used, along with other error terms, to drive the motor to the condition where the velocity feedback is equal to the velocity command.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Velocity Error	REAL	Position Units / Sec

Velocity Integrator Error Velocity Integrator Error is the running sum of the Velocity Error, in the configured axis Position Units per Second, for the specified axis. For an axis with an active velocity servo loop, the velocity integrator error is used, along with other error terms, to drive the motor to the

condition where the velocity feedback is equal to the velocity command.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Velocity Integrator Error	REAL	Position Units – mSec / Sec

Velocity Command Velocity Command is the current velocity reference to the velocity servo loop, in the configured axis Position Units per Second, for the specified axis. The Velocity Command value, hence, represents the output of the outer position control loop. Velocity Command is not to be confused with Command Velocity which represents the rate of change of Command Position input to the position servo loop.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Velocity Command	REAL	Position Units / Sec

Velocity Feedback Velocity Feedback is the actual velocity of the axis as estimated by the SERCOS module, in the configured axis Position Units per second. The estimated velocity is generated by applying a 1 KHz low-pass filter to the change in actual position over the servo update interval. Velocity Feedback is a signed value—the sign (+ or -) depends on which direction the axis is currently moving.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Velocity Feedback	REAL	Position Units / Sec

Acceleration Command Acceleration Command is the current acceleration reference to the output summing junction, in the configured axis Position Units per Second^2, for the specified axis. The Acceleration Command value, hence, represents the output of the inner velocity control loop. Acceleration Command is not to be confused with Command Velocity, which represents the rate of change of Command Position input to the position servo loop.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Acceleration Command	REAL	Position Units / Sec^2

Acceleration Command is the current acceleration reference to the output summing junction, in the configured axis Position Units per Second^2, for the specified axis. The Acceleration Command value, hence, represents the output of the inner velocity control loop. Acceleration Command is not to be confused with Command Velocity,

which represents the rate of change of Command Position input to the position servo loop.

Acceleration Feedback Acceleration Feedback is the actual velocity of the axis as estimated by the servo module, in the configured axis Position Units per Second^2. The Estimated Acceleration is calculated by taking the difference in the Estimated Velocity over the servo update interval. Acceleration Feedback is a signed value—the sign (+ or -) depends on which direction the axis is currently moving. .

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Acceleration Feedback	REAL	Position Units / Sec^2

Marker Distance Marker Distance is the distance between the axis position at which a home switch input was detected and the axis position at which the marker event was detected. This value is useful in aligning a home limit switch relative to a feedback marker pulse to provide repeatable homing operation.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Marker Distance	REAL	Position Units

Torque Command This is the command value when operating in torque mode.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Torque Command	REAL	%Rated

Torque Feedback This is the torque feedback value when operating in torque mode.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Torque Feedback	REAL	%Rated

Pos./Neg. Dynamic Torque Limit These parameters represent the currently operative maximum positive and negative torque/current limit magnitude. Each value should be the lowest value of all torque/current limits in the drive at a given

time. These limits include the amplifier peak limit, motor peak limit, user current limit, amplifier thermal limit, and the motor thermal limit.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Pos. Dynamic Torque Limit Neg. Dynamic Torque Limit	REAL	%Rated

Motor Capacity This parameter displays the present utilization of motor capacity as a percent of rated capacity.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motor Capacity	REAL	%

Drive Capacity This parameter displays the present utilization of drive capacity as a percent of rated capacity.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Drive Capacity	REAL	%

Power Capacity This parameter displays the present utilization of the axis power supply as a percent of rated capacity.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Power Capacity	REAL	%

Bus Regulator Capacity This parameter displays the present utilization of the axis bus regulator as a percent of rated capacity.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Bus Regulator Capacity	REAL	%

Motor Electrical Degrees This parameter is the present electrical angle of the motor shaft.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motor Electrical Angle	REAL	Degrees

DC Bus Voltage This parameter is the present voltage on the DC Bus of the drive.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	DC Bus Voltage	DINT	Volts

Torque Limit Source This parameter displays the present source (if any) of any torque limiting for the axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Torque Limit Source	DINT	Enumeration: 0 = Not Limited 1 = Neg.e Torque Limit 2 = Pos. Torque Limit 3 = Amp Peak Limit 4 = Amp I(t) Limit 5 = Bus Regulator Limit 6 = Bipolar Torque Limit 7 = Motor Peak Limit 8 = Motor I(t) Limit 9 = Voltage Limit

Drive Status Bit Attributes

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Drive Status Bits	DINT	Direct Access Entire DINT - **DriveStatus** 0: Servo Action Status -***No Tag*** 1: Drive Enable Status -***No Tag*** 2: Axis Shutdown Status -***No Tag*** 3: Process Status -**ProcessStatus** 4: *Reserved* 5: *Reserved* 6: Home Input Status -**HomeInputStatus** 7: Registration 1 Input Status -**Reg1Input Status** 8: Registration 2 Input Status -**Reg2InputStatus** 9: Positive Overtravel Input Status -**PosOvertravelInputStatus** 10: Negative Overtravel Input Status -**NegOvertravelInputStatus** 11: Enable Input Status -**EnableInputStatus** 12: Acceleration Limit Status -**AccelLimitStatus** 13: Absolute Reference Status **- AbsoluteReferenceStatus** 14: *Reserved* 15 *Reserved* 16: Velocity Lock Status -**VelocityLockStatus** 17: Velocity Standstill Status -**VelocityStandstillStatus** 18: Velocity Threshold -**VelocityThresholdStatus** 19: Torque Threshold -**TorqueThresholdStatus** 20: Torque Limit Status -**TorqueLimitStatus** 21: Velocity Limit Status -**VelocityLimitStatus** 22: Position Lock Status -**PositionLockStatus** 23: Power Limit Status -**PowerLimitStatus** 24: *Reserved* 25: Lower Velocity Threshold Status -**LowVelocityThresholdStatus** 26: High Velocity Threshold Status -**HighVelocityThresholdStatus** 27-31: *Reserved*

Servo Action Status

The Servo Action Status bit attribute is set when servo loops on the associated with the axis is currently enabled and able to follow command. If the bit is not set then servo action is disabled.

Drive Enable Status

The Drive Enable Status bit attribute is set when the drive's power structure associated with the axis has been activated. If the bit is not set then drive's power structure is currently deactivated.

Shutdown Status

The Shutdown Status bit attribute is set when the associated axis is currently in the Shutdown state. As soon as the axis is transitioned from the Shutdown state to another state, the Shutdown Status bit is cleared.

Process Status

The Process Status bit attribute is set when there is an axis tuning operation or an axis hookup diagnostic test operation in progress on the associated physical axis.

Home Input Status

The Home Input Status bit attribute represents the current state of the dedicated Home input. This bit is set if the Home input is active and clear if inactive.

Registration 1/2 Input Status

The Registration Input 1 and Registration Input 1 Status bit attributes represent the current state of the corresponding dedicated Registration input. This bit is set if the registration input is active and clear if inactive.

Positive Overtravel Input Status

The Positive Overtravel Input Status bit attribute represents the current state of the dedicated Positive Overtravel input. This bit is set if the Positive Overtravel input is active and clear if inactive.

Negative Overtravel Input Status

The Negative Overtravel Input Status bit attribute represents the current state of the dedicated Negative Overtravel input. This bit is set if the Negative Overtravel input is active and clear if inactive.

Enable Input Status

The Enable Input Status bit attribute represents the current state of the dedicated Enable input. This bit is set if the Enable input is active and clear if inactive.

Acceleration Limit Status

The Acceleration Limit Status bit attribute is set when the magnitude of the commanded acceleration to the velocity servo loop input is greater than the configured Velocity Limit.

Absolute Reference Status

The Absolute Reference Status bit attribute is set after an absolute homing procedure. The bit remains set unless the drive resets its configuration parameters to default values or an active or passive home or redefine position is performed on the axis. If the bit is clear, it indicates that the reported position of the axis has not been, or is no longer, referenced to the absolute machine reference system established by an absolute homing procedure.

Velocity Lock Status

The Velocity Lock Status bit attribute is set when the magnitude of the physical axis Velocity Feedback is within the configured Velocity Window of the current velocity command.

Velocity Standstill Status

The Velocity Standstill Status bit attribute is set when the magnitude of the physical axis Velocity Feedback is within the configured Velocity Standstill Window of zero speed.

Velocity Threshold

The Velocity Threshold Status bit attribute is set when the magnitude of the physical axis Velocity Feedback is less than the configured Velocity Threshold.

Torque Limit Status

The Torque Limit Status bit attribute is set when the magnitude of the axis torque command is greater than the configured Torque Limit.

Velocity Limit Status

The Velocity Limit Status bit attribute is set when the magnitude of the commanded velocity to the velocity servo loop input is greater than the configured Velocity Limit.

Position Lock Status

The Position Lock Status bit attribute is set when the magnitude of the axis position error has become less than or equal to the configured Position Lock Tolerance value for the associated physical axis. If this bit is not set then the magnitude of the axis position error is greater than the configured Position Lock Tolerance value.

Power Limit Status

The Power Limit Status bit attribute is set when the magnitude of the actual supplied power is greater than the configured Power Threshold.

Axis Control Bit Attributes

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Axis Control Bits	DINT	0: Abort Process Request 1: Shutdown Request 2: *Reserved* 3: Abort Home Request 4: Abort Event Request 5-14: *Reserved* 15: Change Cmd Reference 16-31: *Reserved*

Abort Process

When the Abort Process bit is set, any active tuning or test process on the drive axis is aborted

Shutdown Request

When the Shutdown Request bit is set, the drive axis is forced into the shutdown state.

Abort Home Request

When the Abort Home Request bit is set, any active homing procedures are cancelled.

Abort Event Request

When the Abort Event Request bit is set, any active registration or watch event procedures are cancelled.

Change Cmd Reference

The Change Command Reference bit attribute is set when the Logix processor has switched to a new position coordinate system for command position. The servo drive processor uses this bit when processing new command position data from the Logix processor to account for the offset implied by the shift in the reference point. The bit is cleared when the drive axis acknowledges completion of the reference position change by clearing its Change Position Reference bit.

Axis Response Bit Attributes

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Axis Control Bits	DINT	0: Abort Process Acknowledge 1: Shutdown Acknowledge 2: *Reserved* 3: Abort Home Acknowledge 4: Abort Event Acknowledge 5-14: *Reserved* 15: Change Pos Reference 16-31: *Reserved*

Abort Process Acknowledge

When the Abort Process Acknowledge bit is set, the servo module acknowledges that the tuning or test process has been aborted

Shutdown Request Acknowledge

When the Shutdown Acknowledge bit is set, the servo module acknowledges that the axis has been forced into the shutdown state.

Abort Home Acknowledge

When the Abort Home Acknowledge bit is set, the servo module acknowledges that the active home procedure has been aborted.

Abort Event Acknowledge

When the Abort Home Acknowledge bit is set, the servo module acknowledges that the active registration or watch position event procedure has been aborted.

Change Pos Reference

The Change Position Reference bit attribute is set when the Servo loop has switched to a new position coordinate system. The Logix processor to uses this bit when processing new position data from the servo drive to account for the offset implied by the shift in the reference point. The bit is cleared when the Logix processor acknowledges completion of the reference position change by clearing its Change Cmd Reference bit.

Drive Fault Bit Attributes

All of the fault bit attributes defined below can be handled by the ControlLogix processor as a Major Fault by configuring the associated Group Object's "General Fault Type Mechanism" attribute accordingly. Otherwise any specific fault handling must be done as part of the user program

.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Drive Fault Bits	DINT	Direct Access – Entire DINT - **DriveFaults** 0: Positive Soft Overtravel Fault -**PosSoftOvertravelFault** 1: Negative Soft Overtravel Fault -**NegSoftOvertravelFault** 2: Positive Hard Overtravel Fault -**PosHardOvertravelFault** 3: Negative Hard Overtravel Fault -**NegHardOvertravelFault** 4: Feedback Fault -**FeedbackFault** 5: Feedback Noise Fault -**FeedbackNoiseFault** 6: Auxiliary Feedback Fault -**AuxFeedbackFault** 7: Auxiliary Feedback Noise Fault -**AuxFeedbackNoiseFault** 8: (reserved) 9: Drive Enable Input Fault -**DriveEnableInputFault** 10 - 12: (reserved) 13: Ground Short Fault -**GroundShortFault** 14: Drive Hardware Fault -**DriveHardFault** 15: Overspeed Fault -**OverspeedFault** 16: Overload Fault -**OverloadFault** 17: Drive Overtemperature Fault -**DriveOvertempFault** 18: Motor Overtemperature Fault -**MotorOvertempFault** 19: Drive Cooling Fault -**DriveCoolingFault** 20: Drive Control Voltage Fault -**DriveControlVoltageFault** 21: Feedback Fault -**Feedback Fault** 22: Commutation Fault -**CommutationFault** 23: Drive Overcurrent Fault -**DriveOvercurrentFault** 24: Drive Overvoltage Fault -**DriveOvervoltageFault** 25: Drive Undervoltage Fault -**DriveUndervoltageFault** 26: Power Phase Loss Fault -**PowerPhaseLossFault** 27: Position Error Fault -**PositionErrorFault** 28: SERCOS Fault -**SERCOSFault** 29: Overtravel Fault -***No Tag*** 30-31: *Reserved*

Positive/Negative Software Overtravel Faults

If either the Positive Soft Overtravel Fault or Negative Soft Overtravel Fault bit attributes are set it indicates that the axis has traveled, or attempted to travel, beyond the current configured values for Maximum Positive Travel or Maximum Negative Travel, respectively.

This fault can only occur when the drive is in the enabled state and the Soft Overtravel Checking bit is set in the Fault Configuration Bits attribute.

If the Soft Overtravel Fault Action is set for Stop Command, the faulted axis can be moved or jogged back inside the soft overtravel limits. Any attempt, however, to move the axis further beyond the soft overtravel limit using a motion instruction results in an instruction error.

As soon as the axis is moved back within the specified soft overtravel limits, the corresponding soft overtravel fault bit is automatically cleared. However the soft overtravel fault persists through any attempt to clear it while the axis position is still beyond the specified travel limits while the axis is enabled.

Positive/Negative Hardware Overtravel Faults

If either the Positive Hard Overtravel Fault or Negative Hard Overtravel Fault bit attributes are set it indicates that the axis has traveled beyond the current position limits as established by hardware overtravel limit switches mounted on the machine. This fault can only occur when the drive is in the enabled state and the Hard Overtravel Checking bit is set in the Fault Configuration Bits attribute.

If the Hard Overtravel Fault Action is set for Stop Command, the faulted axis can be moved or jogged back inside the soft overtravel limits. Any attempt, however, to move the axis further beyond the hard overtravel limit switch using a motion instruction results in an instruction error.

To recover from this fault, the axis must be moved back within normal operation limits of the machine and the limit switch closed. The hard overtravel fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear. Any attempt to clear the fault while the overtravel limit switch is still open and the drive is enabled is unsuccessful.

Position Error Fault

If the Position Error Fault bit attribute is set it indicates that the servo has detected that the axis position error has exceeded the current configured value for Position Error Tolerance. This fault can only occur when the drive is in the enabled state.

This fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear.

Feedback 1 or Feedback 2 Fault

If the Feedback Fault bit is set for a specific feedback source, it indicates, for an A Quad B feedback device, that one of the following conditions occurred:

The differential electrical signals for one or more of the feedback channels (e.g., A+ and A-, B+ and B-, or Z+ and Z- for an A Quad B encoder) are at the same level (both high or both low). Under normal operation, the differential signals are always at *opposite* levels. The most common cause of this situation is a broken wire between the feedback transducer and the servo module or drive.

Loss of feedback “power” or feedback “common” electrical connection between the drive and the feedback device.

This fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear.

Feedback 1 or Feedback 2 Noise Fault

If the Feedback Noise Fault bit attribute is set for a specific feedback source, it indicates that noise has been detected on the feedback devices signal lines. For example, simultaneous transitions of the feedback A and B channels of an A Quad B encoder is referred to generally as feedback noise. When the feedback device is an encoder, feedback noise (shown below) is most often caused by loss of quadrature in the feedback device itself or radiated common-mode noise signals being picked up by the feedback device wiring, both of which may be able to be seen on an oscilloscope.

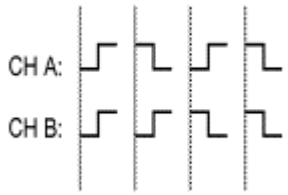


Figure 13.15 Channel Quadrature

For example, loss of channel quadrature for an encoder can be caused by physical misalignment of the feedback transducer components, or excessive capacitance (or other delays) on the encoder signals. Proper grounding and shielding techniques can usually cure radiated noise problems.

This fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear.

Drive Enable Input Fault

This fault would be declared if either one of two possible conditions occur: 1) If an attempt is made to enable the axis (typically via MSO or MAH instruction) while the Drive Enable Input is inactive. 2) If the Drive Enable Input transitions from active to inactive while the axis is enabled.

This fault can only occur when the Drive Enable Input Fault Handling bit is set in the Fault Configuration Bits attribute.

If the Drive Enable Input Fault Action is set for Stop Command and the axis is stopped as a result of a Drive Enable Input Fault, the faulted axis cannot be moved until the fault is cleared. Any attempt to move the axis in the faulted state using a motion instruction results in an instruction error.

Note: If the Drive Enable Fault Action setting is Status Only or Stop Command and an attempt is made to enable the axis (typically via MSO or MAH instruction) while the Drive Enable Input is active, the axis enables in the faulted state indicating a Drive Enable Input Fault. When the Drive Enable Fault Action setting is Stop Command, instructions that both enable the axis and initiate motion (MAH, MRAT, MAHD) abort the motion process leaving the instruction with both the IP and PC bits clear.

This fault condition is latched and requires execution of an explicit MAFR (Motion Axis Fault Reset) or MASR (Motion Axis Shutdown Reset) instruction to clear. Any attempt to clear the fault while the drive enable input is still inactive and the drive is enabled is unsuccessful. However, the drive enable input fault may be cleared with the drive enable input inactive if the drive is disabled.

If the Drive Enable Input Checking bit is clear, then the state of the Drive Enable Input is irrelevant so no fault would be declared in any of the above conditions.

Ground Short Fault

When the drive detects an imbalance in the DC bus supply current, the Ground Short Fault bit is set, indicating that current is flowing through an improper ground connection.

Drive Hardware Fault

The Drive Hardware Fault bit is set when the drive detects a serious hardware fault.

Overspeed Fault

The Overspeed Fault bit is set when the speed of the axis as determined from the feedback has exceeded the overspeed limit which is typically set to 150% of configured velocity limit for the motor.

Overload Fault

When the load limit of the motor/drive is first exceeded, the Overload warning bit is set. If, however, the condition persists, the Overload fault is set. Often this bit is tied into the IT limit of the drive.

Drive Overtemperature Fault

The Drive Overtemperature Fault bit is set when the drive's temperature exceeds the drive shutdown temperature.

Motor Overtemperature Fault

The Motor Overtemperature Fault bit is set when the motor's temperature exceeds the motor shutdown temperature.

Drive Cooling Fault

The Drive Cooling Fault bit is set when the ambient temperature surrounding the drive's control circuitry temperature exceeds the drive ambient shut-down temperature.

Drive Control Voltage Fault

The Drive Control Voltage Fault bit is set when the power supply voltages associated with the drive circuitry fall outside of acceptable limits.

Feedback Fault

The Feedback Fault bit is set when one of the feedback sources associated with the drive axis has a problem that prevents the drive from receiving accurate or reliable position information from the feedback device.

Commutation Fault

The Commutation Fault bit is set when the commutation feedback source associated with the drive axis has a problem that prevents the drive from receiving accurate or reliable motor shaft information to perform commutation.

Drive Overcurrent Fault

The Drive Overcurrent Fault bit is set when drive output current exceeds the predefined operating limits for the drive.

Drive Overvoltage Fault

The Drive Overvoltage Fault bit is set when drive DC bus voltage exceeds the predefined operating limits for the bus.

Drive Undervoltage Fault

The Drive Undervoltage Fault bit is set when drive DC bus voltage is below the predefined operating limits for the bus.

Power Phase Loss Fault

The Power Phase Loss Fault bit is set when the drive detects that one or more of the three power line phases is lost from the 3 phase power inputs.

SERCOS Fault

The SERCOS Fault bit is set when either a requested SERCOS procedure fails to execute properly or the associated drive node has detected a SERCOS communication fault.

Module Fault Bit Attributes

The Module Fault Bit attribute is a collection of all faults that have module scope as opposed to axis scope. Generally, a these module faults are reflected by all axes supported by the associated SERCOS module.

Module Fault attribute information is passed from a physical module or device to the controller via an 8-bit value contained in the in the header of the Synchronous Input connection assembly. Thus, these fault bits are updated every coarse update period by the Motion Task. The module's map driver should also monitor module Faults so module fault conditions can be reflected to the user through the Module Properties dialog.

All of the fault bit attributes defined below can be handled by the ControlLogix processor as a Major Fault by configuring the associated Group Object's "General Fault Type Mechanism" attribute accordingly.

Otherwise any specific fault handling must be done as part of the user program.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Module Fault Bits	DINT	Direct Access Entire DINT - **ModuleFaults** 0: Control Sync Fault -**ControlSyncFault** 1: Module Sync Fault -**ModuleSyncFault** 2: Timer Event Fault -**TimerEventFault** 3: Module Hardware Fault -**ModuleHardwareFault** 4: SERCOS Communications Fault -**SERCOSRingFault** 5-31: *Reserved*

Control Sync Fault

The Control Sync Fault bit attribute is set when the Logix controller detects that several position update messages in a row from the motion module have been missed due to a failure of the synchronous communications connection. This condition results in the automatic shutdown of the associated servo module. The Logix controller is designed to “ride-through” a maximum of four missed position updates without issuing a fault or adversely affecting motion in progress. Missing more than four position updates in a row constitutes a problematic condition that warrants shutdown of the servo module. The Synchronous Connection Fault bit is cleared when the connection is reestablished.

Module Sync Fault

The Module Sync Fault bit attribute is set when the motion module detects that several position update messages in a row from the ControlLogix processor module have been missed due to a failure of the synchronous communications connection. This condition results in the automatic shutdown of the servo module. The servo module is designed to “ride-through” a maximum of four missed position updates without issuing a fault or adversely affecting motion in progress. Missing more than four position updates in a row constitutes a problematic condition that warrants shutdown of the servo module. The Synchronous Connection Fault bit is cleared when the connection is reestablished.

Timer Event Fault

If the Timer Event Fault bit attribute is set it indicates that the associated servo module has detected a problem with the module’s

timer event functionality used to synchronize the motion module's servo loop to the master timebase of the Logix rack (i.e. Coordinated System Time). The Timer Event Fault bit can only be cleared by reconfiguration of the motion module.

Module Hardware Fault

If the Module Hardware Fault bit attribute is set it indicates that the associated servo module has detected a hardware problem that, in general, is going to require replacement of the module to correct.

SERCOS Ring Fault

The SERCOS Ring Fault bit sets when the SERCOS module detects that a problem has occurred on the SERCOS ring; i.e. the light has been broken or a drive has been powered down.

Drive Warning Bit Attributes

All of the warning bit attributes defined below are not supported in the initial release of this object.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Drive Warning Bits	DINT	Direct Access Entire DINT - **DriveWarnings** 0: Drive Overload Warning -**DriveOverloadWarning** 1: Drive Overtemperature Warning -**DriveOvertempWarning** 2: Motor Overtemperature Warning -**MotorOvertempWarning** 3: Cooling Error Warning -**CoolingErrorWarning** 4-31: *Reserved*

Overload Warning

When the load limit of the motor is exceeded, the Overload Warning bit is set. If the condition persists, an Overload Fault occurs. This warning bit gives the control program an opportunity to reduce motor loading to avoid a future shutdown situation.

Drive Overtemperature Warning

When the over-temperature limit of the drive is exceeded, the Drive Overtemperature Warning bit is set. If the condition persists, a Drive Overtemperature Fault occurs. This warning bit gives the control program an opportunity to reduce motor loading, or increasing drive cooling, to avoid a future shutdown situation.

Motor Overtemperature Warning

When the over-temperature limit of the motor is exceeded, the Motor Overtemperature Warning bit is set. If the condition persists, an Motor Overtemperature Fault occurs. This warning bit gives the control program an opportunity to reduce motor loading, or increasing motor cooling, to avoid a future shutdown situation.

Cooling Error Warning

When the ambient temperature limit inside the drive enclosure is exceeded, the Cooling Error Warning bit sets. If the condition persists, a Cooling Error Fault occurs. This warning bit gives the control program an opportunity to increase drive cooling to avoid a future shutdown situation.

Attribute Error Code

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Attribute Error Code	INT	ASA Error code returned by erred set attribute list service to the module.

When an Axis Configuration Fault occurs, one or more axis parameters associated with a SERCOS module or drive has not been successfully updated to match the value of the corresponding parameter of the local controller. The fact that the configuration of the drive axis no longer matches the configuration of the local controller is a serious fault and results in the shutdown of the faulted axis. The Attribute Error Code is reset to zero by reconfiguration of the motion module.

Axis Configuration Fault information is passed from the SERCOS module or device to the controller via a 16-bit ASA status word contained in the Set Attribute List service response received by the controller. A Set Attribute List service to the motion module can be initiated by a software Set Attribute List service to the controller, or by an SSV instruction within the controller's program, referencing a servo attribute. Various routines that process responses to motion services are responsible for updating these attributes.

The Set and Get service responses provide a status response with each attribute that was processed. That status value is defined by ASA as follows: UINT16, Values 0-255 (0x00-0xFF) are reserved to mirror common service status codes. Values 256 – 65535 are available for object/class attribute specific errors. For a list of ASA error codes see Appendix B.

Attribute Error ID

The Attribute Error ID is used to retain the ID of the servo attribute that returned a non-zero attribute error code resulting in an Axis Configuration Fault. The Attribute Error ID defaults to zero and, after a fault has occurred may be reset to zero by reconfiguration of the motion module.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	Attribute Error ID	INT	Attribute ID associated with non-zero Attribute Error Code.

SERCOS Error Code

The SERCOS Error Code value can be used to identify the source of the drive parameter update failure that resulted in the Axis Configuration Fault. The error codes for this attribute are derived from the IEC-1394 SERCOS Interface standard.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV*	SERCOS Error Code	INT	Error code returned by SERCOS module indicating source of drive parameter update failure (See Appendix C)

The SERCOS Error Code value can be used to identify the source of the drive parameter update failure that resulted in the Axis Configuration Fault. The error codes for this attribute are derived from the IEC-1394 SERCOS Interface standard.

Commissioning Status Attributes

The list of Commissioning Status Attributes associated with the Axis Object provides access to attributes associated with the state of various motion instruction generated commissioning processes. Motion instructions involved in commissioning an axis are MRAT (Motion Run Axis Tune) and MRHD (Motion Run Hookup Diagnostic) which are described in detail in the AC Motion Instruction Specification. Commissioning Status Attributes are primarily used by external software (e.g. RSLogix5000) to implement the Test and Tuning dialogs associated with the axis configuration tool. However, these same attributes may also be used as part of the user program to implement a “built-in” axis test and tuning procedure. A list of all Commissioning Status Attributes is shown in the table below.

In order for position unit-based attributes to return a meaningful value, the ‘Conversion Constant’ Axis Configuration Attribute must be established. Furthermore, attributes having time units (Position Units / Sec) must also have a valid coarse update period which is established through association with a fully configured Motion Group Object.

Test Status

The Test Status attribute returns status of the last run MRHD (Motion Run Hookup Diagnostic) instruction that initiates a hookup diagnostic process on the targeted SERCOS module axis. The Test Status attribute can, thus, be used to determine when the MRHD initiated operation has successfully completed. Conditions may occur, however, that make it impossible for the control to properly perform the operation. When this is the case, the test process is automatically aborted and a test fault reported that is stored in the Test Status output parameter.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Test Status	INT	Enumeration: 0 = test process successful 1 = test in progress 2 = test process aborted by user 3 = test process time-out fault (~2 seconds) 4 = test failed – servo fault 5 = test failed – insufficient test increment 6 = test failed – wrong polarity 7 = test failed – missing signal 8 = test failed – device comm error 9 = test failed – feedback config error 10 = test failed – motor wiring error

Test Direction Forward

The Test Direction Forward attribute reports the direction of axis travel during the hookup test as seen by the SERCOS drive during the last test process initiated by a MRHD (Motion Run Hookup Test) instruction. A Test Direction value of 1 (forward) indicates that the direction of motion as observed by the SERCOS drive was in the forward (clockwise or positive) direction. Note that the value for Test Direction, as determined by the MRHD process, does not depend on the Drive Polarity attribute configuration. This value, combined with the Test Output Polarity is used by the MAHD (Motion Apply Hookup Test) instruction to properly configure the Drive Polarity attribute for correct directional sense.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Test Direction Forward	SINT	0 = reverse 1 = forward

Test Output Polarity

The Test Output Polarity attribute reports the sign of the output torque command applied by the drive to the motor during the last test process initiated by a MRHD (Motion Run Hookup Test) instruction. A Test Output Polarity value of 0 (positive) indicates that the sign of the torque command applied by the SERCOS drive during the test was positive. A Test Output Polarity value of 1 (negative) indicates that the sign of the torque command applied by the SERCOS drive during the test was negative. This condition occurs when the drive hookup test is

unsuccessful in moving the required Test Increment while applying a positive torque. This situation can occur when testing a linear axis that is up against a hard stop.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Test Output Polarity	SINT	0 = positive 1 = negative

Tune Status

The Tune Status attribute returns status of the last run MRAT (Motion Run Axis Tuning) instruction that initiates a tuning process on the targeted SERCOS module axis. The Tune Status attribute can, thus, be used to determine when the MRAT initiated operation has successfully completed. Conditions may occur, however, that make it impossible for the control to properly perform the operation. When this is the case, the tune process is automatically aborted and a tune fault reported that is stored in the Tune Status output parameter.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Status	INT	Enumeration: 0 = tune process successful 1 = tune in progress 2 = tune process aborted by user 3 = tune process time-out fault 4 = tune process failed due to drive fault 5 = axis reached Tuning Travel Limit 6 = axis polarity set incorrectly 7 = tune measurement fault 8 = tune configuration fault

Tune Acceleration/Deceleration Time

The Tune Acceleration Time and Tune Deceleration Time attributes return acceleration and deceleration time in seconds for the last run MRAT (Motion Run Axis Tune) instruction. These values are used to calculate the Tune Acceleration and Tune Deceleration attributes.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Acceleration Time	REAL	Sec
GSV	Tune Deceleration Time	REAL	Sec

Tune Acceleration/Deceleration

The Tune Acceleration Time and Tune Deceleration attributes return the measured acceleration and deceleration values for the last run MRAT (Motion Run Axis Tuning) instruction. These values are used, in the case of an external torque servo drive configuration, to calculate the Tune Inertia value of the axis, and are also typically used by a subsequent MAAT (Motion Apply Axis Tune) to determine the tuned

values for the Maximum Acceleration and Maximum Deceleration attributes.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Acceleration	REAL	Position Units / Sec2
GSV	Tune Deceleration	REAL	Position Units / Sec2

Tune Inertia

The Tune Inertia value represents the total inertia for the axis as calculated from the measurements made during the last MRAT (Motion Run Axis Tune) initiated tuning process. In actuality, the units of Tune Inertia are not industry standard inertia units but rather in terms of percent (%) of rated drive output per MegaCounts/Sec^2 of feedback input. In this sense it represents the input gain of torque servo drive. These units represent a more useful description of the inertia of the system as seen by the servo controller. The Tune Inertia value is used by the MAAT (Motion Apply Axis Tune) instruction to calculate the Torque Scaling.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Tune Inertia	REAL	% / MegaCounts Per Sec^2

If the Tune Inertia value exceeds 100%Rated/MegaCounts Per Second^2, performance of the digital servo loop may be compromised due to excessive digitization noise associated with the velocity estimator. This noise is amplified by the Torque Scaling gain which is related to the Tune Inertia factor and passed on to the torque output of the drive. A high Tune Inertia value can, thus, result in excitation of mechanical resonances and also result in excessive heating of the motor due to high torque ripple. The only solution to this problem is to lower the loop bandwidths and optionally apply some output filtering.

Since the Tune Inertia value represents a measure of the true system inertia, this situation can occur when driving a high inertia load relative to the motor, i.e. a high inertia mismatch. But it can also occur when working with a drive that is undersized for the motor or with a system having low feedback resolution. In general, the lower the Tune Inertia the better the performance of the digital servo loops approximates that of an analog servo system.

Enhancements have been made to the Logix tuning algorithm to address excessive noise issues by managing quantization noise levels. The product of the Tune Inertia (% Rated/MCPS) and the Velocity Servo BW (Hertz) can be calculated to directly determine quantization noise levels. Based on this product, the tuning algorithm can take

action to limit high frequency noise injection to the motor. These are the actions that have been recently implemented:

For motors with a Tune Inertia BW product of 1000 or more, the LP Filter is applied with a Filter BW of 5x the Velocity Servo Bandwidth in Hertz. This limits the amount of phase lag introduced by the LP filter to ~12 degrees which is relatively small compared to the 30 to 60 degrees of phase margin that we have for a typical tuned servo system. With a typical tuned LP filter BW value of 200 Hz, we can expect the high frequency quantization noise in the 1 KHz range to be attenuated roughly by a factor of 5.

When the Tune Inertia BW product reaches 4000 or more, the LP filter alone is not going to be enough to manage the quantization noise level. So the tune algorithm begins to taper the system bandwidth by the ratio of 4000/(Tune Inertia * Vel Servo BW). This holds the quantization noise level at a fixed value, independent of the Tune Inertia BW product. For example, Dave's 420 motor with a Tune Inertia value of 213 and a Vel Servo BW of 41 Hz (8733 Inertia BW product) tunes with a Pos P Gain of 46 and a Vel P Gain of 117 and LP Filter BW of 93. This he has found to be a good noise free gain set.

Servo Drive Configuration Attributes

The following sections define in more detail the behavior of all the various configuration attributes associated with the Servo Drive data type of the Motion Axis Object. The attributes, by definition, have read-write access. The Servo Drive Configuration Attributes are divided into seven categories: Drive Configuration, Motor and Feedback, Drive Gains, Drive Limits, Drive Offsets, Drive Power, and Drive Commissioning attributes. These categories correspond roughly to the organization of the RSLogix 5000 Axis Properties pages.

Many of the following Drive Configuration attributes are associated with corresponding attributes contained in the SERCOS Axis Object associated with the 1756M08SE 8-Axis SERCOS module. When any of these attributes are modified by a Set Attribute List service or an SSV instruction within the user program, the local processor value for the attribute is immediately changed and a Set Attribute List service to the SERCOS module is initiated to update the working value stored in the drive. The progress of this update can be monitored, if necessary, within the user program through the Configuration Update in Process bit of the Axis Status Bits attribute.

Drive Configuration

The Drive Configuration attributes provide basic drive configuration information. These parameters are used to determine the specific drive, axis type, servo configuration, as well as determine drive polarity and fault handling behavior.

Drive ID

The Drive ID attribute contains the ASA Product Code of the drive amplifier associated with the axis. If the Product Code does not match that of the actual drive amplifier, an error is generated during the configuration process.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Drive Axis ID	INT	Product Code of Drive Amplifier

Servo Loop Configuration

The Servo Loop Configuration attribute determines the specific configuration of the servo loop topology when the Drive Axis Configuration is set to "servo". The Servo Loop Configuration establishes several advanced drive configuration attributes that are part of the SERCOS Interface standard.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Servo Loop Configuration	INT	Enumeration: 0 = custom 1 = feedback only 2 = aux. feedback only 3 = position servo 4 = aux. position servo 5 = dual position servo 6 = dual command servo 7 = aux. dual command servo 8 = velocity servo 9 = torque servo 10 = dual command/feedback servo

Advanced Servo Configuration Attributes

The above advanced attributes map directly to SERCOS IDNs. Thus, for a detailed description of these attributes refer to the corresponding IDN descriptions found in the SERCOS Interface standard. Since these attributes are automatically configured based on the current Servo Loop Configuration, the user need not be concerned with manually configuring each of these attributes.

WARNING

Changing the auto-configured values of the above advanced attributes can result in unpredictable motion behavior. Therefore these values read-only for 1st release.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Primary Operation Mode	INT	Bit Map: x000 = no mode x001 = torque servo x010 = vel servo x011 = pos servo w/ fdbk1 x100 = pos servo w/ fdbk2 x101 = pos servo w/ fdbk1and 2 x110 = (reserved) x111 = no servo
GSV	Telegram Type	INT	Enumeration: 0 = no cyclic data 1 = trq cmd 2 = vel cmd, vel fbk 3 = vel cmd, pos fbk 4 = pos cmd, pos fbk 5 = pos/vel cmd, pos fbk and vel fbk 6 = vel cmd 7 = applic. Telegram (default)
GSV	AT Configuration list	Struct { INT; DINT [16]}	Struct {length; data[ ]}
GSV	MDT Configuration list	Struct { INT; DINT [4]}	Struct {length; data[ ]} its

Fault Configuration Bits

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Fault Configuration Bits	DINT	Bit Field: 0: Soft Overtravel Checking 1: Hard Overtravel Checking 2-3: Reserved 4: Drive Enable Input Fault Checking 5: Drive Enable Input Checking 6-31: Reserved Overtravel Checking for Linear Axis Only; Change to Rotary or Overtravel Checking requires Home range checks.

Soft Overtravel Checking

When the Soft Overtravel Checking bit is set it enables a periodic test that monitors the current position of the axis and issues a Positive Soft Overtravel Fault or Negative Soft Overtravel Fault if ever the axis position travels outside the configured travel limits. The travel limits

are determined by the configured values for the Maximum Positive Travel and Maximum Negative Travel attributes. This software overtravel check is not a substitute, but rather a supplement, for hardware overtravel fault protection which uses hardware limit switches to directly stop axis motion at the drive and deactivate power to the system.

If the Soft Overtravel Checking bit is clear (default), then no software overtravel checking is done.

Software overtravel checking is only available for a linear servo axes.

Hard Overtravel Checking

When the Hard Overtravel Checking bit is set it enables a periodic test that monitors the current state of the positive and negative overtravel limit switch inputs and issues a Positive Hard Overtravel Fault or Negative Hard Overtravel Fault if ever the axis position travels activates the limit switch inputs.

If the Hardware Overtravel Checking bit is clear (default), then no overtravel limit switch input checking is done.

Hardware overtravel checking is only available for a linear servo axes.

Drive Enable Input Fault Handling

When the Drive Enable Input Fault Handling bit is set, it enables the drive to post a fault based on the condition of the Drive Enable Input. If an attempt is made to enable the drive axis without an active Drive Enable Input, the drive declares a Drive Enable Input Fault. Also if the Drive Enable Input ever transitions from active to inactive while the drive axis is enabled, the drive also declares a Drive Enable Input Fault.

If the Drive Enable Input Fault Handling bit is clear (default), then the drive does not generate a Drive Enable Input Fault.

Drive Enable Input Checking

When the Drive Enable Input Checking bit is set (the default) the drive is regularly checks the current state of the Drive Enable Input. This dedicated input serves as a permissive to enable the drive's power structure and servo loop. Once the drive is enabled, a transition of the Drive Enable Input from active to inactive results in a drive initiated axis stop where the axis is decelerated to a stop using the configured Stopping Torque and then disabled.

If the drive enable Input Checking bit is clear, then no Drive Enable Input checking is done, hence the state of the input is irrelevant to drive operation. The state of the switch is still reported as part of the Drive Status bits attribute.

Drive Units

The Drive Units attribute establishes the unit of measure that is applied to the Drive Resolution attribute value. Units appearing in the enumerated list may be linear or rotary, english or metric. Further discrimination is provided in the enumerated list to specify whether the Drive Unit is referenced directly to the motor or to the external, or auxiliary feedback.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Drive Unit	INT	Enumeration: 0 = motor revs 1 = aux revs 2 = motor inches 3 = aux inches 4 = motor mm 5 = aux mm

Drive Resolution

The Drive Resolution attribute determines how many Drive Counts there are in a Drive Unit. Drive Units may be configured as Revs, Inches, or Millimeters depending on the specific drive application. Furthermore, the configured Drive Unit may apply to either a motor or auxiliary feedback device. All position, velocity, and acceleration data to the drive is scaled from the user's Position Units to Drive Units based on the Drive Resolution and Conversion Constant. The ratio of the Conversion Constant to Drive Resolution determines the number of Position Units in a Drive Unit.

Conversion Constant / Drive Resolution = Drive Units (rev, inch, or mm) / Position Unit

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Drive Resolution	DINT	Drive Counts / Drive Unit

Conversely, all position, velocity, and acceleration data from the drive is scaled from the user's Position Units to Drive Units based on the Drive Resolution and Conversion Constant. The ratio of Drive Resolution and the Conversion Constant determines the number of Position Units in a Drive Unit.

Drive Resolution / Conversion Constant = Position Units / Drive Unit (rev, inch, or mm)

In general, the Drive Resolution value may be left at its default value of 200000 Drive Counts per Drive Unit, independent of the resolution of the feedback device(s) used by the drive. This is because the drive has its own set of scale factors that it uses to relate feedback counts to drive counts.

Drive Travel Range Limit

Because the drive's position parameters are ultimately limited to signed 32-bit representation per the SERCOS standard, the Drive Resolution parameter impacts the drive's travel range. The equation for determining the maximum travel range based on Drive Resolution is as follows:

Drive Travel Range Limit = +/- 2,147,483,647 / Drive Resolution.

Based on a default value of 200,000 Drive Counts per Drive Unit, the drive's range limit is 10,737 Drive Units. While it is relatively rare for this travel range limitation to present a problem, it is a simple matter to lower the Drive Resolution to increase the travel range. The downside of doing so is that the position data is then passed with lower resolution that could affect the smoothness of motion.

Fractional Unwind

In some cases, however, the user may also want to specifically configure Drive Resolution value to handle fractional unwind applications or multi-turn absolute applications requiring cyclic compensation. In these cases where the Unwind value for a rotary application does not work out to be an integer value, the Rotational Position Scaling attribute may be modified to a value that is integer divisible by the Unwind value.

The following examples demonstrate how the Drive Resolution value may be used together with the Conversion Constant to handle various applications.

Rotary Gear-Head WITHOUT Aux Feedback Device

Based on a rotary motor selection, Drive Resolution would be expressed as Drive Counts per Motor Rev and be applied to the Rotational Position Resolution IDN. The user would set the Conversion Constant to Drive Counts per user-defined Position Unit. If it is a 3:1 gearbox, and the user's Position Unit is, say, Revs of the gear output shaft, the Conversion Constant is 200,000/3, which is irrational! But, in this case, the user could simply set the Drive Resolution to 300,000 Drive Counts/Motor Rev and the Conversion Constant could then be set to 100,000 Drive Counts/Output Shaft Rev. This system would work with this configuration without any loss of mechanical precision, i.e. a move of 1 output shaft revolution would move the output shaft exactly 1 revolution.

Linear Ball-Screw WITHOUT Aux Feedback Device

Again, based on a rotary motor selection, Drive Resolution would be expressed as Drive Counts per Motor Rev and be applied to the Rotational Position Resolution IDN. The user would set the Conversion Constant to Drive Counts per user-defined Position Unit. If it is a 5mm pitch ball-screw, and the user's Position Unit is, say, mm, the user simply sets the Conversion Constant to 200,000/5 or 40,000 Drive Counts per mm based on the default Drive Resolution value of 200,000 Drive Counts/Motor Rev. If the pitch is irrational, the method for addressing this is the same as described above.

Rotary Gear-Head WITH Aux Feedback Device

Based on a rotary motor feedback selection, Drive Resolution would be expressed as Drive Counts per Aux Rev and be applied to the Rotational Position Resolution IDN. Now that position is based on the auxiliary feedback device according to the Servo Loop Configuration, the Data Reference bit of the various Scaling Types should be Load Referenced rather than Motor Referenced.

(The motor feedback would be rotary and resolution expressed in cycles per motor rev. The aux feedback device is also rotary and its resolution expressed in cycles per aux rev. The Aux Feedback Ratio would be set to the number of aux feedback revs per motor rev and internally applied to IDNs 121 and 122 for the purpose of relating position servo loop counts to velocity servo loop counts in a dual servo loop configuration. The Aux Feedback Ratio attribute is also used in range limit and default value calculations during configuration based on the selected motor’s specifications.)

If the application uses a 3:1 gearbox, and the user's Position Unit is, say, Revs of the gearbox output shaft, the Conversion Constant is still rational, since our scaling is Load Referenced! The user simply sets the Conversion Constant to 200,000 Drive Counts/Output Shaft Rev based on the default Drive Resolution value of 200,000 Drive Counts/Aux Rev. The system would work in this configuration without any loss of mechanical precision, i.e. a move of 1 output shaft revolution would move the output shaft exactly 1 revolution.

Linear Ball-Screw/Ball-Screw Combination WITH Aux Feedback Device

Based on a linear aux feedback selection, Drive Resolution would be expressed as Drive Counts per Linear Unit, say Millimeters (Metric bit selection), and be applied to the Linear Position Data Scaling IDNs. Now that position is based on the auxiliary feedback device according to the Servo Loop Configuration, the Data Reference bit of the various

Scaling Types should again be Load Referenced rather than Motor Referenced.

The motor feedback would be rotary and resolution expressed in cycles per motor rev. The aux feedback device is now linear and its resolution expressed in cycles per, say, mm. The Aux Feedback Ratio would be set to the number of aux feedback units (mm) per motor rev and internally applied to IDNs 123 the purpose of relating position servo loop counts to velocity servo loop counts in a dual servo loop configuration. The Aux Feedback Ratio attribute is also used in range limit and default value calculations during configuration based on the selected motor's specifications.

If the application uses a 3:1 gearbox and a 5 mm pitch ball-screw, and the user's Position Unit is, say, cm, the Conversion Constant is again rational, since we are Load Referenced! The user sets the Conversion Constant to 20,000 Drive Counts/cm based on the default Drive Resolution value of 200000 Drive Counts/mm. This system would work in this configuration without any loss of mechanical precision, i.e. a move of 10 cm would move the actuator exactly 10 cm.

Advanced Scaling Attributes

The Drive Scaling Bits attribute configuration is derived directly from the Drive Units attribute.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Drive Scaling Bits	DINT	Bit map: 0: Scaling type 0 – standard 1 – custom 1: Scaling unit 0 – rotary 1 – linear 2: Linear scaling unit 0 – metric 1 – english 3: Data Reference 0 – motor 1 – load 3-31: *Reserved*

Scaling Type

The Scaling Type bit attribute is used to enable custom scaling using the position, velocity, acceleration, and torque scaling parameters defined by the SERCOS Interface standard. When the bit is clear (default), these scaling parameters are all set based on the preferred Rockwell Automation SERCOS drive scaling factors. Currently there is no Logix support for custom scaling.

Scaling Unit

The Scaling Unit attribute is used to determine whether the Logix processor scales position, velocity, and acceleration attributes based on rotary or metric scaling parameters and their associated Drive Units that are defined by the SERCOS Interface standard. When the bit is clear (default), the corresponding bits in the SERCOS Position Data Scaling, Velocity Data Scaling, and Acceleration Data Scaling parameters are also cleared, which instructs the drive to use the rotary scaling parameters. When the bit is set, the corresponding bits in the SERCOS Position Data Scaling, Velocity Data Scaling, and Acceleration Data Scaling parameters are also set, which instructs the drive to use the linear scaling parameters.

Linear Scaling Unit

When the Scaling Unit is set to linear, the Linear Scaling bit attribute is used to determine whether the Logix processor scales position, velocity, and acceleration attributes based on Metric or English Drive Units as defined by the SERCOS Interface standard. When the bit is clear (default), the corresponding bits in the SERCOS Position Data Scaling, Velocity Data Scaling, and Acceleration Data Scaling parameters are also cleared, which instructs the drive to use the Metric scaling parameters. When the bit is set, the corresponding bits in the SERCOS Position Data Scaling, Velocity Data Scaling, and Acceleration Data Scaling parameters are also set, which instructs the drive to scale in English units.

If the Scaling Unit is set to rotary, the Linear Scaling Unit bit has no affect.

When interfacing to Rockwell SERCOS drive products, the Standard Drive Units based on the Scaling Unit and Linear Scaling Unit bit selections are shown in the following table:

Standard Drive Units		
	Metric	**English**
Rotary	Rev	Rev
Linear	Millimeter	Inch

Data Reference

The Data Reference bit determines which side of the mechanical transmission to reference position, velocity, acceleration, and torque data. If motor is selected then position, velocity, acceleration, and torque data is referenced to the motor side of the transmission. If load is selected then position, velocity, acceleration, and torque data is

referenced to the load-side of the transmission. This is only applicable when using an auxiliary feedback device.

The following advanced attributes are derived from the Drive Scaling Bits attribute. These attributes are automatically configured to appropriate defaults.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Data Scaling	INT	Default: rotary axis in Revs
GSV	Position Data Scaling Factor	DINT	(see IEC 1491)
GSV	Position Data Scaling Exp.	INT	(see IEC 1491)
GSV	Rotational Pos. Resolution	DINT	Drive Units per Rev
GSV	Velocity Data Scaling	INT	Default: rotary axis in RPM
GSV	Velocity Data Scaling Factor	DINT	(see IEC 1491)
GSV	Velocity Data Scaling Exp.	INT	(see IEC 1491)
GSV	Accel Data Scaling	INT	Default: rotary axis in Rad/sec^2
GSV	Accel Data Scaling Factor	DINT	(see IEC 1491)
GSV	Accel Data Scaling Exp.	INT	(see IEC 1491)
GSV	Torque/Force Data Scaling	INT	Default: %
GSV	Torque Data Scaling Factor	DINT	(see IEC 1491)
GSV	Torque Data Scaling Exp.	INT	(see IEC 1491)

WARNING

Changing the auto-configured values of the above advanced attributes can result in unpredictable motion behavior. Therefore values read-only for 1st release.

Drive Polarity

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Data Scaling	INT	Default: rotary axis in Revs
GSV	Position Data Scaling Factor	DINT	(see IEC 1491)
GSV	Position Data Scaling Exp.	INT	(see IEC 1491)
GSV	Rotational Pos. Resolution	DINT	Drive Units per Rev

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Velocity Data Scaling	INT	Default: rotary axis in RPM
GSV	Velocity Data Scaling Factor	DINT	(see IEC 1491)
GSV	Drive Polarity	DINT	Enumeration: 0 = Custom Polarity 1 = Positive Polarity 2 = Negative Polarity

Custom Polarity

Custom Polarity is used to enable custom polarity configurations using the various polarity parameters defined by the SERCOS Interface standard.

Positive/Negative Polarity

Positive and Negative Polarity bit attribute determines the overall polarity of the servo loop of the drive. All the advanced polarity parameters are automatically set based on whether the Drive Polarity is configured as Positive or Negative. Proper wiring guarantees that the servo loop is closed with negative feedback. However there is no such guarantee that the servo drive has the same sense of forward direction as the user for a given application. Negative Polarity inverts the polarity of both the command position and actual position data of the servo drive. Thus, selecting either Positive or Negative Drive Polarity makes it possible to configure the positive direction sense of the drive to agree with that of the user. This attribute is configured automatically using the MRHD and MAHD motion instructions. Refer to the Logix Motion Instruction Specification for more information on these hookup diagnostic instructions.

Advanced Polarity Attributes

The above advanced attributes are derived from the Drive Polarity Bits attribute and map directly to SERCOS IDNs. Thus, for a detailed description of these attributes refer to the corresponding IDN descriptions found in the SERCOS Interface standard. Since these attributes are automatically configured to appropriate values based on the current Drive Polarity Bits settings, the user need not be concerned with manually configuring each of these attributes. Generally, all command bits is set according to the current Command

Polarity bit value, and the feedback bits is set according to the current Feedback Polarity bit setting.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Position Polarity	INT	Position Polarity Bit Map: 0: pos cmd 1: additive pos cmd 2: pos feedback 1 3: pos feedback 2 4: use position limits 5: use under/over-flow Polarity bits: bit = 0 – non-inverted bit = 1 – inverted
GSV	Velocity Polarity	INT	Velocity Polarity Bit Map: 0: vel cmd 1: additive vel cmd 2: vel feedback Polarity bits: bit = 0 – non-inverted bit = 1 – inverted
GSV	Torque Polarity	INT	Torque Polarity Bit Map: 0: torque cmd 1: additive torque cmd 2: torque feedback Polarity bits: bit = 0 – non-inverted bit = 1 – inverted

WARNING

Changing the auto-configured values of the above advanced attributes can result in unpredictable motion behavior. Therefore these values read-only for 1st release.

Axis Info Select

Axis Info Select attributes are used to enable periodic data updates for selected drive status attributes. This method of accessing drive status data is designed to reduce the flow of unnecessary data for the SERCOS module. By selecting the drive status attribute of interest from the enumerated list, this attribute's value is transmitted along with the actual position data to the Logix processor. Thus, the drive status data update time is precisely the coarse update period. Once the servo status attributes of interest are periodically updated in this fashion, the values of these attributes may be accessed via the standard GSV or Get Attribute List service. Note, if a GSV is done to one of these drive

status attributes without the having selected this attribute via the Axis Info Select attribute, the attribute value is static and will not reflect the true value in the drive.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Axis Info Select 1 Axis Info Select 2	DINT	Enumeration: 0 = None (default) 1 = Position Command 2 = Position Feedback 3 = Aux Position Feedback 4 = Position Error 5 = Position Int. Error 6 = Velocity Command 7 = Velocity Feedback 8 = Velocity Error 9 = Velocity Int. Error 10 = Accel. Command 11 = Accel. Feedback 12 = (reserved 13 = Marker Distance 14 = Torque Command 15 = Torque Feedback 16 = Pos Dynamic Torque Limit 17 = Neg Dynamic Torque Limit 18 = Motor Capacity 19 = Drive Capacity 20 = Power Capacity 21 = Bus Regulator Capacity 22 = Motor Electrical Angle 23 = Torque Limit Source 24 = DC Bus Voltage 25 = Reserved

Motor and Feedback Configuration

This section covers the various drive attributes that provide motor and feedback device configuration information.

Motor ID

The Motor ID attribute contains the enumeration of the specific A-B motor catalog number associated with the axis. If the Motor ID does not match that of the actual motor, an error is generated during the drive configuration process.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motor ID	INT	

Motor Data

The Motor Data attribute is a structure with a length element and an array of bytes that contains important motor configuration information needed by an A-B SERCOS drive to operate the motor. The length element represents the number of valid data elements in the data

array. The meaning of data within the data array is understood only by the drive. The block of data stored in the Motor Data attribute is derived at configuration time from an RSLogix 5000 motion database file.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motor Data	Struct { INT; SINT [256]}	Struct {length; data[ ]}

Feedback Type

The Motor and Aux Feedback Type attributes are used to identify the motor mounted or auxiliary feedback device connected to the drive. A list of A-B feedback devices supported at the time of this writing is as follows:

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motor Feedback Type Aux Feedback Type	INT	)

Feedback Type	Code	Rotary Only	Linear Only	Rotary or Linear
<None>	0x0000	-	-	-
SRS	0x0001	X		
SRM	0x0002	X		
SCS	0x0003	X		
SCM	0x0004	X		
SNS	0x0005	X		
MHG	0x0006	X		
Resolver	0x0007	X		
Analog Reference	0x0008	X		
Sin/Cos	0x0009			X
TTL	0x000A			X
UVW	0x000B			X
Unknown Stegmann	0x000C			X
Endat	0x000D			X
RCM21S-4	0x000E	X		
RCM21S-6	0x000F	X		
RCM21S-8	0x0010	X		

Feedback Type	Code	Rotary Only	Linear Only	Rotary or Linear
LINCODER	0x0011		X	
Sin/Cos with Hall	0x0012			X
TTL with Hall	0x0013			X

Feedback Units

The Motor Feedback Units attribute establishes the unit of measure that is applied to the Motor Feedback Resolution attribute value. The Aux Feedback Units attribute establishes the unit of measure that is applied to the Aux Feedback Resolution attribute value. Units appearing in the enumerated list cover linear or rotary, english or metric feedback devices.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motor Feedback Units Aux Feedback Units	INT	Enumeration: 0 = revs 1 = inches 2 = mm

Feedback Resolution

The Motor and Aux Feedback Resolution attributes are used to provide the A-B drive with the resolution of the associated feedback device in cycles per feedback unit. These parameters provide the SERCOS drive with critical information needed to compute scaling factors used to convert Drive Counts to Feedback counts.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motor Feedback Resolution Aux Feedback Resolution	DINT	Cycles per Motor Feedback Unit Cycles per Aux Feedback Unit

Aux Feedback Ratio

The Aux Feedback Ratio attribute represents the quantitative relationship between auxiliary feedback device and the motor. For a rotary auxiliary feedback device, this attributes value should be the turns ratio between the auxiliary feedback device and the motor shaft. For linear auxiliary feedback devices, this attribute value would typically represent the feed constant between the motor shaft and the linear actuator.

The Aux Feedback Ratio attribute is used in calculating range limits and default value calculations during configuration based on the

selected motor's specifications. The value is also used by the drive when running the dual feedback servo loop configuration.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Aux Feedback Ratio	FLOAT	Aux Feedback Units per Motor Feedback Unit

Feedback Configuration

Both the Logix controller and the SERCOS drive use the Motor and Auxiliary Feedback Configuration attributes to control the scaling of the associated feedback device counts. These attributes are derived from the corresponding Motor and Auxiliary Feedback Unit attributes.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motor Feedback Configuration Aux Feedback Configuration	INT	Bit map: 0: Feedback type 0 – rotary 1 – linear 1: (reserved) 2: Linear feedback unit 0 – metric 1 – english 3: Feedback Polarity (Aux Only) 0 – not inverted 1 – inverted 4-15: *Reserved*

Feedback Type

The Feedback Type bit attribute is used to determine how the drive scales the feedback counts into drive counts. When the bit is clear (default), the feedback type is rotary, so the associated Feedback Resolution attribute is expressed as Feedback Cycles per Feedback Rev. When the bit is set, the feedback type is linear and the associated Feedback Resolution attribute is interpreted as Feedback Cycles per inch or mm.

Linear Feedback Unit

The Linear Feedback unit bit attribute is used to determine whether the Logix processor scales the feedback counts based on Metric or English Feedback Units. When the bit is clear (default), the drive is to use Metric feedback scaling, so the associated Feedback Resolution attribute is expressed as Feedback Cycles per mm. When the bit is set, the drive is to use English feedback scaling, so the associated Feedback Cycles attribute is interpreted as Feedback Cycles per inch.

If the Feedback Type is set to rotary, the Linear Scaling Unit bit has no affect.

When interfacing to Rockwell SERCOS drive products, the Standard Feedback Units specified using the above Feedback Configuration bit selections are shown in the following table:

Standard Feedback Units		
	Metric	**English**
Rotary	Rev	Rev
Linear	Millimeter	Inch

Feedback Polarity

The Feedback Polarity bit attribute can be used to change the sense of direction of the feedback device. This bit is only valid for auxiliary feedback devices. When performing motor/feedback hookup diagnostics on an auxiliary feedback device using the MRHD and MAHD instructions, the Feedback Polarity bit is configured for the auxiliary feedback device to insure negative feedback into the servo loop. Motor feedback devices must be wired properly for negative feedback since the Feedback Polarity bit is forced to 0, or non-inverted.

The above Motor and Aux Feedback Configuration attributes map directly to SERCOS IDNs. Thus, for further description of these attributes refer to the corresponding IDN descriptions found in the SERCOS Interface standard.

Feedback Interpolation

The Feedback Interpolation attributes establish how many Feedback Counts there are in one Feedback Cycle. The Feedback Interpolation Factor depends on both the feedback device and the drive feedback circuitry. Quadrature encoder feedback devices and the associated drive feedback interface typically support 4x interpolation, so the Interpolation Factor for these devices would be set to 4 Feedback Counts per Cycle (Cycles are sometimes called Lines). High Resolution Sin/Cosine feedback device types can have interpolation factors as high as 2048 Counts per Cycle. The product to the Feedback Resolution and the corresponding Feedback Interpolation Factor is the overall resolution of the feedback channel in Feedback Counts per Feedback Unit. In our example, a Quadrature encoder with a 2000 line/rev resolution and 4x interpolation factor would have an overall resolution of 8000 counts/rev.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Motor Feedback Interpolation Factor Aux Feedback Interpolation Factor	DINT	Feedback Counts per Cycle

Servo Loop Block Diagrams

The following section illustrates the various servo loop configurations that are supported with the first release of this object. Which of these servo loop topologies is in effect depends on the current settings of the of the Servo Loop Configuration and External Drive Type attributes.

Motor Position Servo

The Motor Position Servo configuration provides full position servo control using only the motor mounted feedback device to provide position and velocity feedback. This servo configuration is a good choice in applications where smoothness and stability are more important that positioning accuracy. Positioning accuracy is limited due to the fact that the controller has no way of compensating for non-linearity in the mechanics external to the motor. Note that the motor mounted feedback device also provides motor position information necessary for commutation. Synchronous input data to the servo loop includes Position Command, Velocity Offset, and Torque Offset. These values are updated at the coarse update rate of the associated motion group. The Position Command value is derived directly from the output of the motion planner, while the Velocity Offset and Torque Offset values are derived from the current value of the corresponding attributes. These offset attributes may be changed programmatically via SSV instructions or direct Tag access which,

when used in conjunction with future Function Block programs, provides custom “outer” control loop capability.

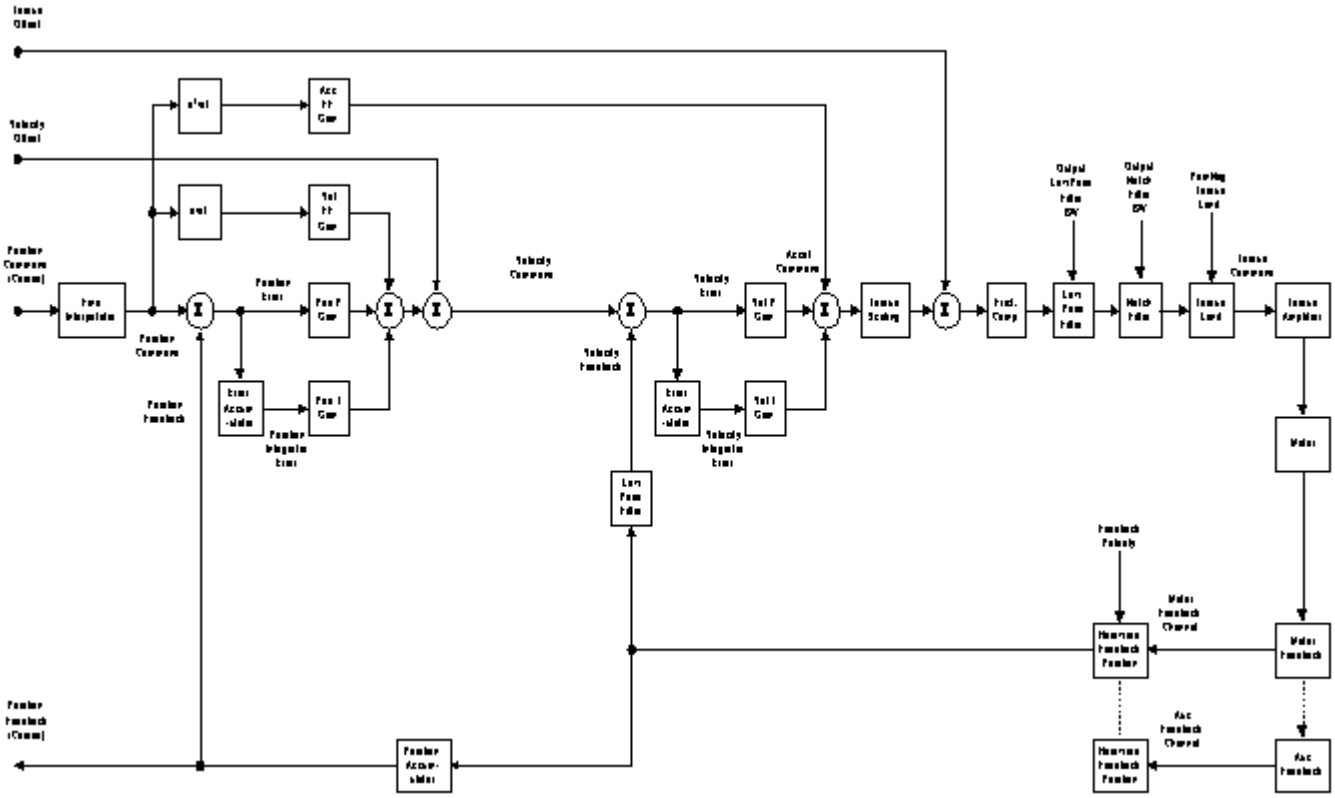


Figure 13.16 Motor Position Servo

Auxiliary Position Servo

The Auxiliary Position Servo configuration provides full position servo control using an auxiliary (i.e., external to the motor) feedback device to provide position and velocity feedback. This servo configuration is a good choice in applications positioning accuracy is important. The smoothness and stability may be limited, however, due to the mechanical non-linearities external to the motor. Note, that the motor mounted feedback device is still required to provide motor position information necessary for commutation. Synchronous input data to the servo loop includes Position Command, Velocity Offset, and Torque Offset. These values are updated at the coarse update rate of the associated motion group. The Position Command value is derived directly from the output of the motion planner, while the Velocity Offset and Torque Offset values are derived from the current value of the corresponding attributes. These offset attributes may be changed programmatically via SSV instructions or direct Tag access which,

when used in conjunction with future Function Block programs, provides custom “outer” control loop capability.

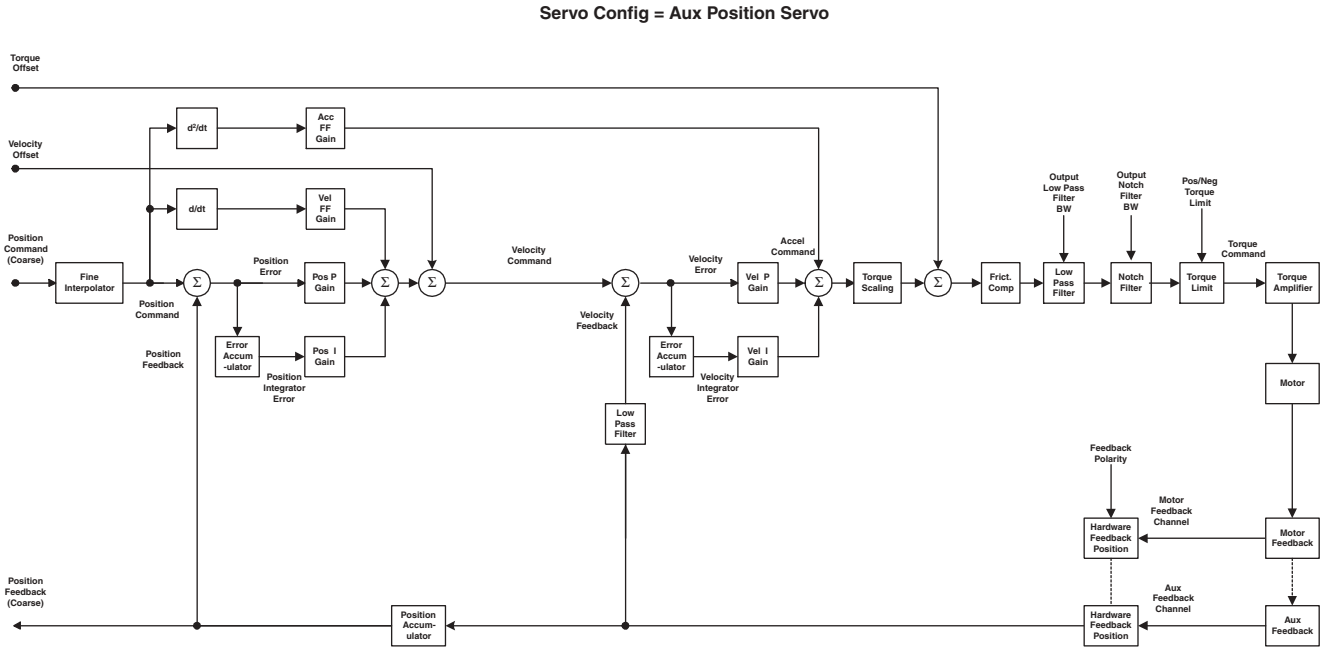


Figure 13.17 Auxiliary Position Servo

Dual Feedback Servo

This configuration provides full position servo control using the auxiliary feedback device for position feedback and the motor mounted feedback device to provide velocity feedback. This servo configuration combines the advantages of accurate positioning associated with the auxiliary position servo with the smoothness and stability of the motor position servo configuration. Note that the motor mounted feedback device also provides motor position information necessary for commutation. Synchronous input data to the servo loop includes Position Command, Velocity Offset, and Torque Offset. These values are updated at the coarse update rate of the associated motion group. The Position Command value is derived directly from the output of the motion planner, while the Velocity Offset and Torque Offset values are derived from the current value of the corresponding attributes. These offset attributes may be changed programmatically via SSV instructions or direct Tag access which, when used in

conjunction with future Function Block programs, provides custom "outer" control loop capability.

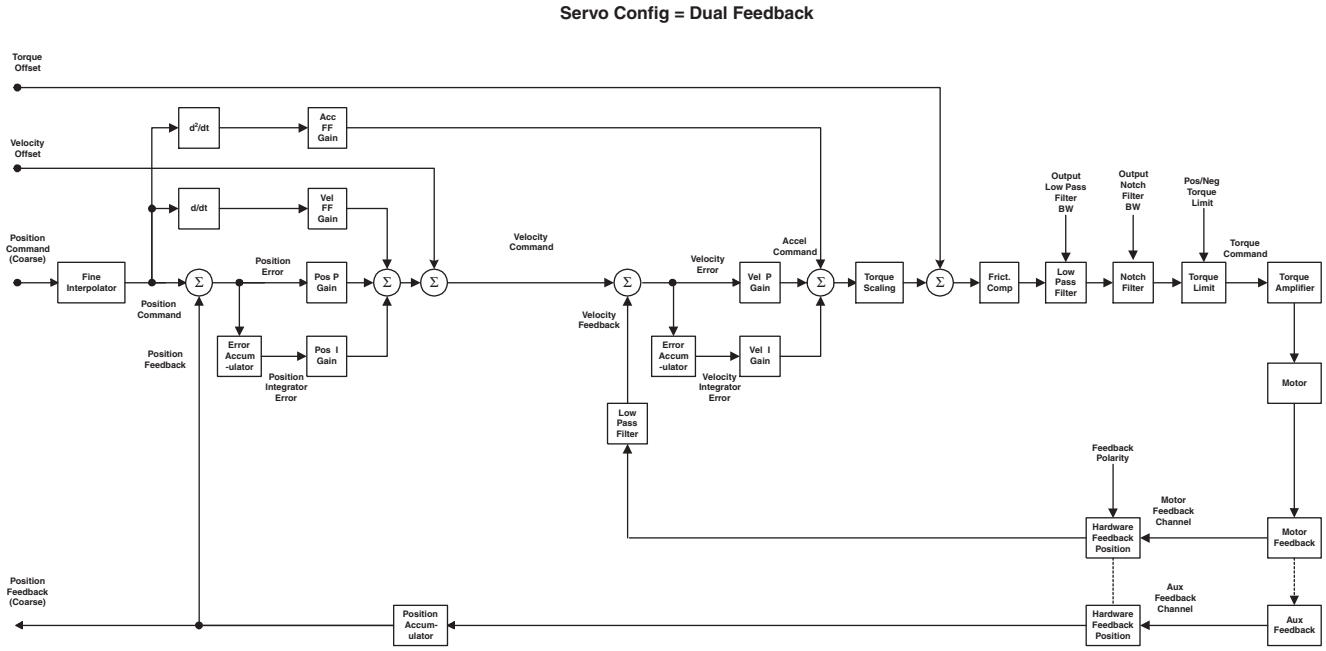


Figure 13.18 Dual Feedback Servo

Motor Dual Command Servo

The Motor Dual Command Servo configuration provides full position servo control using only the motor mounted feedback device to provide position and velocity feedback. Unlike the Motor Position Servo configuration, however, both command position and command velocity are applied to the loop to provide smoother feedforward behavior. This servo configuration is a good choice in applications where smoothness and stability are important. Positioning accuracy is limited due to the fact that the controller has no way of compensating for non-linearities in the mechanics external to the motor. Note that the motor mounted feedback device also provides motor position information necessary for commutation. Synchronous input data to the servo loop includes Position Command, Velocity Command, and Velocity Offset. These values are updated at the coarse update rate of the associated motion group. The Position and Velocity Command values are derived directly from the output of the motion planner, while the Velocity Offset value is derived from the current value of the corresponding attributes. The velocity offset attribute may be changed programmatically via SSV instructions or direct Tag access which,

when used in conjunction with future Function Block programs, provides custom “outer” control loop capability.

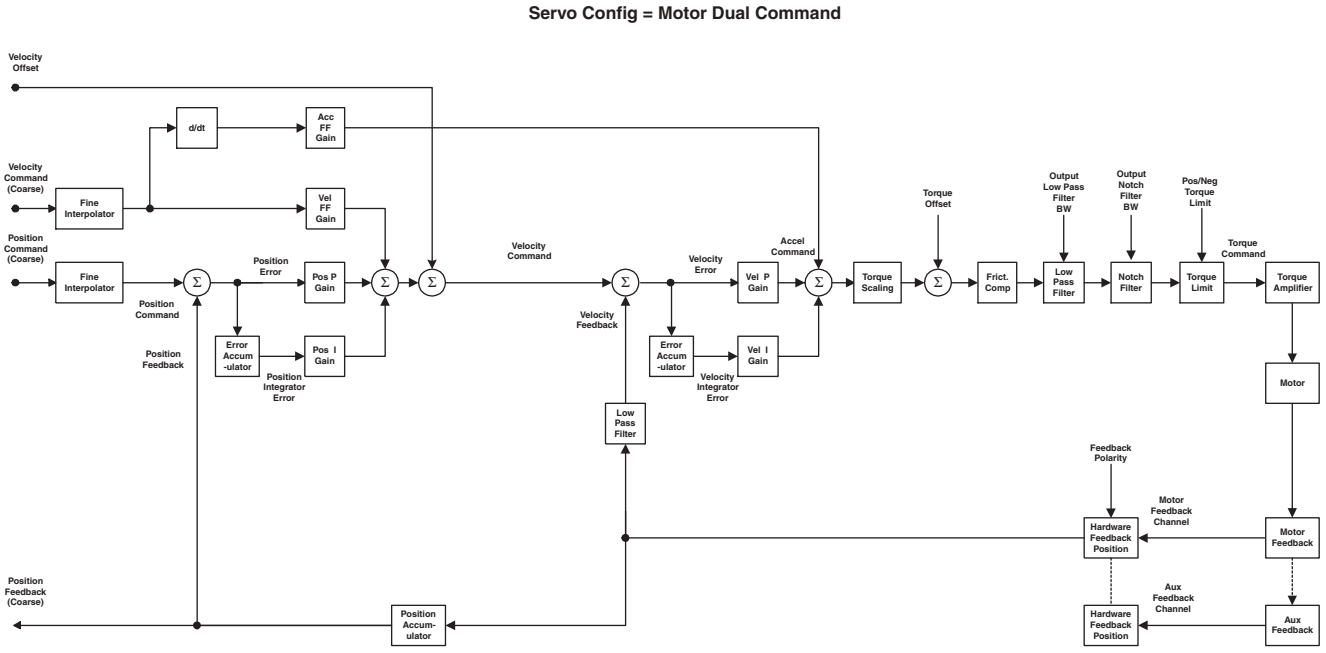


Figure 13.19 Motor Dual Command Servo

Auxiliary Dual Command Servo

The Auxiliary Dual Command Servo configuration provides full position servo control using only the auxiliary mounted feedback device to provide position and velocity feedback. Unlike the Auxiliary Position Servo configuration, however, both command position and command velocity are applied to the loop to provide smoother feedforward behavior. This servo configuration is a good choice in applications where positioning accuracy and good feedforward performance is important. The smoothness and stability may be limited, however, due to the mechanical non-linearities external to the motor. Note, that the motor mounted feedback device is still required to provide motor position information necessary for commutation. Synchronous input data to the servo loop includes Position Command, Velocity Command, and Velocity Offset. These values are updated at the coarse update rate of the associated motion group. The Position and Velocity Command values are derived directly from the output of the motion planner, while the Velocity Offset value is derived from the current value of the corresponding attributes. The velocity offset attribute may be changed programmatically via SSV instructions or direct Tag access which, when used in conjunction with future

Function Block programs, provides custom “outer” control loop capability.

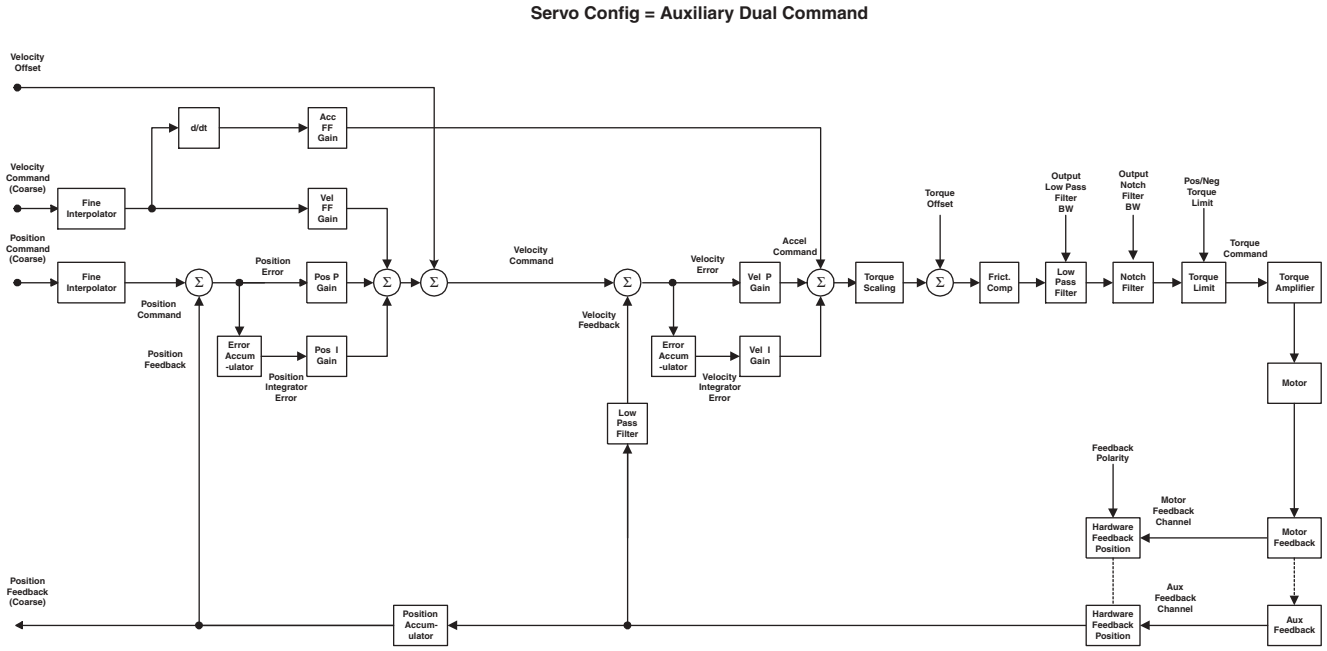


Figure 13.20 Auxiliary Dual Command Servo

Dual Command Feedback Servo

The Motor Dual Command Feedback Servo configuration provides full position servo control using the auxiliary feedback device for position feedback and the motor mounted feedback device to provide velocity feedback. Unlike the Dual Feedback Servo configuration, however, both command position and command velocity are also applied to the loop to provide smoother feedforward behavior. This servo configuration is a good choice in applications where smoothness and stability are important as well as positioning accuracy. Note, that the motor mounted feedback device is still required to provide motor position information necessary for commutation. Synchronous input data to the servo loop includes Position Command, Velocity Command, and Velocity Offset. These values are updated at the coarse update rate of the associated motion group. The Position and Velocity Command values are derived directly from the output of the motion planner, while the Velocity Offset value is derived from the current value of the corresponding attributes. The velocity offset attribute may be changed programmatically via SSV instructions or direct Tag access which, when used in conjunction with future Function Block programs, provides custom “outer” control loop capability.

Velocity Servo

The Velocity Servo configuration provides velocity servo control using the motor mounted feedback device. Synchronous input data to the

servo loop includes Velocity Command, Velocity Offset, and Torque Offset. These values are updated at the coarse update rate of the associated motion group. The Velocity Command value is derived directly from the output of the motion planner, while the Velocity Offset and Torque Offset values are derived from the current value of the corresponding attributes. These offset attributes may be changed programmatically via SSV instructions or direct Tag access which, when used in conjunction with future Function Block programs, provides custom "outer" control loop capability.

Torque Servo

The Torque Servo configuration provides torque servo control using only the motor mounted feedback device for commutation. Synchronous input data to the servo loop includes only the Torque Offset. This values are updated at the coarse update rate of the associated motion group. The Torque Offset value is derived from the current value of the corresponding attribute. This offset attribute may be changed programmatically via SSV instructions or direct Tag access which, when used in conjunction with future Function Block programs, provides custom "outer" control loop capability.

Drive Gains

Rockwell Automation servo drives use Nested Digital Servo Control Loop such as shown in the block diagrams above, consisting typically of a position loop with proportional, integral and feed-forward gains around a digitally synthesized inner velocity loop, again with proportional and integral gains for each axis. These gains provide software control over the servo dynamics, and allow the servo system to be completely stabilized. Unlike analog servo controllers, these digitally set gains do not drift. Furthermore, once these gains are set for a particular system, another SERCOS module programmed with these gain values will operate identically to the original one.

Position Proportional Gain

The Position Error is multiplied by the Position Proportional Gain, or Pos P Gain, to produce a component to the Velocity Command that ultimately attempts to correct for the position error. Increasing this gain value increases the bandwidth of the position servo loop and results in greater "static stiffness" of the axis which is a measure of the corrective force that is applied to an axis for a given position error. Too little Pos P Gain results in excessively compliant, or mushy, axis behavior. Too large a Pos P Gain, on the other hand, can result in axis oscillation due to classical servo instability.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Proportional Gain	REAL	1/Sec

A well-tuned system will move and stop quickly or “smartly” and exhibit little or no “ringing” during constant velocity or when the axis stops. If the response time is poor, or the motion “sloppy” or slow, the proportional gain may need to be increased. If excessive ringing or overshoot is observed when the motor stops, the proportional gain may need to be decreased.

While the Pos P Gain is typically established by the automatic servo tuning procedure, the Pos P gain may also be set manually. Before doing this it must be stressed that the Torque Scaling factor for the axis must be established for the drive system. Refer to Torque Scaling attribute description for an explanation of how the Torque Scaling factor can be calculated. Once this is done the Pos P Gain can be computed based on either the desired loop gain or the desired bandwidth of the position servo system.

Loop Gain Method

If you know the desired loop gain in Inches per Minute per mil or millimeters per minute per mil, use the following formula to calculate the corresponding P gain.

Pos P Gain = 16.667 * Desired Loop Gain (IPM/mil)

Thus, according to an old machine tool rule of thumb, a loop gain of 1 IPM/mil (Pos P gain = 16.7 Sec^{-1}) provides stable positioning for virtually any axis. In general, however, modern position servo systems typically run much tighter than this. The typical value for the Position Proportional Gain is ~100 Sec^{-1}.

Bandwidth Method

If you know the desired unity gain bandwidth of the position servo in Hertz, use the following formula to calculate the corresponding P gain.

Pos P Gain = Bandwidth (Hertz) / 6.28

In general, modern position servo systems typically run with a unit gain bandwidth of ~16 Hertz. The typical value for the Position Proportional Gain is ~100 Sec^{-1}.

Maximum Bandwidth

There are limitations to the maximum bandwidth that can be achieved for the position loop based on the dynamics of the inner velocity and torque loops of the system and the desired damping of the system, Z. These limitations may be expressed as follows:

Bandwidth (Pos) = 0.25 * $1/Z^2$ * Bandwidth (Vel) = 0.25 * $1/Z^2$ * Bandwidth (Torque)

For example, if the bandwidth of the drive's torque loop is 100 Hz and the damping factor, Z, is 0.8, the velocity bandwidth is approximately 40 Hz and the position bandwidth is 16 Hz. Based on these numbers the corresponding proportional gains for the loops can be computed. Note that the bandwidth of the torque loop includes feedback sampling delay and filter time constant.

Position Integral Gain

Position Integral Gain, or Pos I Gain, improves the steady-state positioning performance of the system. By using Position Integral Gain, it is possible to achieve accurate axis positioning despite the presence of such disturbances as static friction or gravity. Increasing the integral gain generally increases the ultimate positioning accuracy of the system. Excessive integral gain, however, results in system instability.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Integral Gain	REAL	1/mSec-Sec

At every servo update the current Position Error is accumulated in a variable called the Position Integral Error. This value is multiplied by the Position Integral Gain to produce a component to the Velocity Command that attempts to correct for the position error. The characteristic of Pos I Gain correction, however, is that any non-zero Position Error will accumulate in time to generate enough force to make the correction. This attribute of Pos I Gain makes it invaluable in applications where positioning accuracy or tracking accuracy is critical. The higher the Pos I Gain value the faster the axis is driven to the zero Position Error condition. Unfortunately, Pos I Gain control is intrinsically unstable. Too much Pos I Gain will result in axis oscillation and servo instability.

If the axis is configured for an external velocity loop servo drive, the Pos I Gain should be zero–most analog velocity loop servo amplifiers have integral gain of their own and will not tolerate *any* amount of Pos I Gain in the position loop without producing severe oscillations. If Pos I Gain is necessary for the application, the velocity integrator in the drive must be disabled.

In certain cases, Pos I Gain control is disabled. One such case is when the servo output to the axis' drive is saturated. Continuing integral control behavior in this case would only exacerbate the situation. Another common case is when performing certain motion. When the Integrator Hold Enable attribute is set, the servo loop automatically disables the integrator during commanded motion.

While the Pos I Gain, if employed, is typically established by the automatic servo tuning procedure, the Pos I Gain value may also be set manually. Before doing this it must be stressed that the Torque Scaling factor for the axis must be established for the drive system. Refer to Torque Scaling attribute description for an explanation of how the Torque Scaling factor can be calculated. Once this is done the Pos I Gain can be computed based on the current or computed value for the Pos P Gain using the following formula:

$$\text{Pos I Gain} = 0.25 * 0.001\ \text{Sec/mSec} * (\text{Pos P Gain})^2$$

Assuming a Pos P Gain value of 100 Sec^{-1} this results in a Pos I Gain value of 2.5 ~0.1 $mSec^{-1}$-Sec^{-1}

Velocity Feedforward Gain

Servo Drives require non-zero command input to generate steady-state axis acceleration or velocity. To provide the non-zero output from the drive to the motor, a non-zero position or velocity error needs to be present. We call this dynamic error while moving "following error". Well, this non-zero following error condition is a situation are trying to avoid. We ideally want zero following error -- all the time. This could be achieved through use of the position integral gain controls as described above, but typically the response time of the integrator action is too slow to be effective. An alternative approach that has superior dynamic response is to use Velocity and Acceleration Feedforward.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Feedforward Gain	REAL	%

The Velocity Feedforward Gain attribute is used to provide the Velocity Command output necessary to generate the commanded velocity. It does this by scaling the current command velocity (derivative of command position) by the Velocity Feedforward Gain and adding it as an offset to the Velocity Command generated by the position loop control elements. With this done, the position loop control elements do not need to generate much of a contribution to the Velocity Command, hence the Position Error value is significantly reduced. The Velocity Feedforward Gain allows the following error of the servo system to be reduced to nearly zero when running at a constant speed. This is important in applications such as electronic gearing and synchronization applications where it is necessary that the actual axis position not significantly lag behind the commanded position at any time.

The optimal value for Velocity Feedforward Gain is 100% theoretically. In reality, however, the value may need to be tweaked to accommodate velocity loops with non-infinite loop gain and other

application considerations. One thing that may force a smaller Velocity Feedforward value is that increasing amounts of feedforward tends to exacerbate axis overshoot. If necessary, the Velocity Feedforward Gain may be "tweaked" from the 100% value by running a simple user program that jogs the axis in the positive direction and monitor the Position Error of the axis during the jog. Increase the Velocity Feedforward Gain until the Position Error at constant speed is as small as possible, but still positive. If the Position Error at constant speed is negative, the actual position of the axis is *ahead* of the command position. If this occurs, decrease the Velocity Feedforward Gain such that the Position Error is again positive. Note that reasonable maximum velocity, acceleration, and deceleration values must be entered to jog the axis.

Acceleration Feedforward Gain

The Acceleration Feedforward Gain attribute is used to provide the Torque Command output necessary to generate the commanded acceleration. It does this by scaling the current Command Acceleration by the Acceleration Feedforward Gain and adding it as an offset to the Servo Output generated by the servo loop. With this done, the servo loops do not need to generate much control effort, hence the Position and/or Velocity Error values are significantly reduced. When used in conjunction with the Velocity Feedforward Gain, the Acceleration Feedforward Gain allows the following error of the servo system during the acceleration and deceleration phases of motion to be reduced to nearly zero. This is important in applications such as electronic gearing and synchronization applications where it is necessary that the actual axis position not significantly lag behind the commanded position at any time.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Acceleration Feedforward Gain	REAL	%

The optimal value for Acceleration Feedforward is 100% theoretically. In reality, however, the value may need to be tweaked to accommodate torque loops with non-infinite loop gain and other application considerations. One thing that may force a smaller Acceleration Feedforward value is that increasing amounts of feedforward tends to exacerbate axis overshoot.

When necessary, the Acceleration Feedforward Gain may be "tweaked" from the 100% value by running a simple user program that jogs the axis in the positive direction and monitors the Position Error of the axis during the jog. Usually Acceleration Feedforward is used in tandem with Velocity Feedforward to achieve near zero following error during the entire motion profile. To fine-tune the Acceleration Feedforward Gain, the Velocity Feedforward Gain must first be optimized using the procedure described above. While capturing the

peak Position Error during the acceleration phase of the jog profile, increase the Acceleration Feedforward Gain until the peak Position Error is as small as possible, but still positive. If the peak Position Error during the acceleration ramp is negative, the actual position of the axis is *ahead* of the command position during the acceleration ramp. If this occurs, decrease the Acceleration Feedforward Gain such that the Position Error is again positive. To be thorough the same procedure should be done for the deceleration ramp to verify that the peak Position Error during deceleration is acceptable. Note that reasonable maximum velocity, acceleration, and deceleration values must be entered to jog the axis.

Velocity Proportional Gain

The standard RA SERCOS drive's digital velocity loop provides damping without the requirement for an analog tachometer. The Velocity Error is multiplied by the Velocity Proportional Gain to produce a Torque Command that ultimately attempts to correct for the velocity error, creating the damping effect. Thus, increasing the Velocity Proportional Gain results in smoother motion, enhanced acceleration, reduced overshoot, and greater system stability. The velocity loop also allows higher effective position loop gain values to be used, however, too much Velocity Proportional Gain leads to high frequency instability and resonance effects. Note that units for Velocity Proportional Gain are identical to that of the Position Proportional Gain making it easy to perform classic calculations to determine damping and bandwidth.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Proportional Gain	REAL	1/Sec

The standard RA SERCOS drive's digital velocity loop provides damping without the requirement for an analog tachometer. The Velocity Error is multiplied by the Velocity Proportional Gain to produce a Torque Command that ultimately attempts to correct for the velocity error, creating the damping effect. Thus, increasing the Velocity Proportional Gain results in smoother motion, enhanced acceleration, reduced overshoot, and greater system stability. The velocity loop also allows higher effective position loop gain values to be used, however, too much Velocity Proportional Gain leads to high frequency instability and resonance effects. Note that units for Velocity Proportional Gain are identical to that of the Position Proportional Gain making it easy to perform classic calculations to determine damping and bandwidth.

If you know the desired unity gain bandwidth of the velocity servo in Hertz, use the following formula to calculate the corresponding P gain.

Vel P Gain = Bandwidth (Hertz) / 6.28

In general, modern velocity servo systems typically run with a unit gain bandwidth of ~40 Hertz. The typical value for the Velocity Proportional Gain is ~250 Sec^{-1}.

Maximum Bandwidth

There are limitations to the maximum bandwidth that can be achieved for the velocity loop based on the dynamics of the inner torque loop of the system and the desired damping of the system, Z. These limitations may be expressed as follows:

$$\text{Bandwidth (Velocity)} = 0.25 * 1/Z^2 * \text{Bandwidth (Torque)}$$

For example, if the bandwidth of the drive's torque loop is 100 Hz and the damping factor, Z, is 0.8, the velocity bandwidth is approximately 40 Hz. Based on this number the corresponding gains for the loop can be computed. Note that the bandwidth of the torque loop includes feedback sampling delay and filter time constant.

Velocity Integral Gain

When configured for a torque (current) loop servo drive, every servo update the current Velocity Error is also accumulated in variable called the Velocity Integral Error. This value is multiplied by the Velocity Integral Gain to produce a component to the Torque Command that attempts to correct for the velocity error. The characteristic of Vel I Gain correction, however, is that any non-zero Velocity Error will accumulate in time to generate enough force to make the correction. This attribute of Vel I Gain makes it invaluable in applications where velocity accuracy is critical. The higher the Vel I Gain value the faster the axis is driven to the zero Velocity Error condition. Unfortunately, I Gain control is intrinsically unstable. Too much I Gain will result in axis oscillation and servo instability.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Integral Gain	REAL	1/mSec

In certain cases, Vel I Gain control is disabled. One such case is when the servo output to the axis' drive is saturated. Continuing integral control behavior in this case would only exacerbate the situation. Another common case is when performing certain motion. When the Integrator Hold Enable attribute is set, the servo loop automatically disables the integrator during commanded motion.

Due to the destabilizing nature of Integral Gain, it is recommended that Position Integral Gain and Velocity Integral Gain be considered mutually exclusive. If Integral Gain is needed for the application use one or the other, but not both. In general, where static positioning accuracy is required, Position Integral Gain is the better choice.

While the Vel I Gain, if employed, is typically established by the automatic servo tuning procedure, the Pos I Gain value may also be set manually. Before doing this it must be stressed that the Torque Scaling factor for the axis must be established for the drive system. Refer to Torque Scaling attribute description for an explanation of how the Torque Scaling factor can be calculated. Once this is done the Vel I Gain can be computed based on the current or computed value for the Vel P Gain using the following formula:

$$\text{Vel I Gain} = 0.25 * 0.001 \text{ Sec/mSec} * (\text{Vel P Gain})^2$$

Assuming a Vel P Gain value of 0.25 Sec^{-1} this results in a Vel I Gain value of ~15.6 $mSec^{-1}$-Sec^{-1-}

Output LP Filter Bandwidth

The Output LP (Low Pass) Filter Bandwidth attribute controls the bandwidth of the drives low-pass digital output filter. The programmable low-pass output filter is bypassed if the configured Output LP Filter Bandwidth for this filter is set to zero (the default). This output filter can be used to filter out, or reduce, high frequency variation of the drive output to the motor. The lower the Output LP Filter Bandwidth, the greater the attenuation of these high frequency components of the output signal. Unfortunately, since the low-pass filter adds lag to the servo loop which pushes the system towards instability, decreasing the Output LP Filter Bandwidth usually requires lowering the Position or Velocity Proportional Gain of the system to maintain stability.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Output LP Filter Bandwidth	REAL	Hertz

The Output LP (Low Pass) Filter Bandwidth attribute controls the bandwidth of the drives low-pass digital output filter. The programmable low-pass output filter is bypassed if the configured Output LP Filter Bandwidth for this filter is set to zero (the default). This output filter can be used to filter out, or reduce, high frequency variation of the drive output to the motor. The lower the Output LP Filter Bandwidth, the greater the attenuation of these high frequency components of the output signal. Unfortunately, since the low-pass filter adds lag to the servo loop which pushes the system towards instability, decreasing the Output LP Filter Bandwidth usually requires lowering the Position or Velocity Proportional Gain of the system to maintain stability.

The output filter is particularly useful in high inertia applications where resonance behavior can severely restrict the maximum bandwidth capability of the servo loop.

Output Notch Filter Frequency

The Output Notch Filter Frequency attribute controls the center frequency of the drive's digital notch filter. Currently implemented as a 2^{nd} order digital filter with a fixed Q, the Notch Filter provides approximately 40DB of output attenuation at the Notch Filter Frequency. The programmable notch filter is bypassed if the configured Output Notch Filter Frequency for this filter is set to zero (the default). This output notch filter is particularly useful in attenuating mechanical resonance phenomena.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Output Notch Filter Frequency	REAL	Hertz

The output filter is particularly useful in high inertia applications where mechanical resonance behavior can severely restrict the maximum bandwidth capability of the servo loop.

Torque Scaling

The Torque Scaling attribute is used to convert the acceleration of the servo loop into equivalent % rated torque to the motor. This has the effect of "normalizing" the units of the servo loops gain parameters so that their values are not affected by variations in feedback resolution, drive scaling, motor and load inertia, and mechanical gear ratios. In fact, the Torque Scaling value, when properly established, represents the inertia of the system and is related to the Tune Inertia value by a factor of the Conversion Constant. The Torque Scaling value is typically established by the drive's automatic tuning procedure but the value can be manually calculated, if necessary, using the following guidelines.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Torque Scaling	REAL	%Rated/ Position Units Per Second^2

Torque Scaling = 100% Rated Torque / (Acceleration @ 100% Rated Torque)

For example, if this axis is using position units of motor revolutions (revs), and that with 100% rated torque applied to the motor, the motor accelerates at a rate of 3000 Revs/Sec^2, the Torque Scaling attribute value would be calculated as shown below.

Torque Scaling = 100% Rated / (3000 RPS^2) = 0.033% Rated/ Revs Per Second^2

Note that if the Torque Scaling value does not reflect the true torque to acceleration characteristic of the system, the gains will also not reflect the true performance of the system.

Integrator Hold Enable

When the Integrator Hold Enable attribute value is configured TRUE, the servo loop temporarily disables any enabled integrators while the command position is changing. This feature is used by point-to-point moves to minimize the integrator wind-up during motion. When the Integrator Hold Enable attribute value is FALSE, all active integrators are always enabled.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Integrator Hold Enable	SINT	0 = disabled 1 = enabled

Advanced Drive Gain Attributes

The following advanced attributes map directly to SERCOS IDNs. Thus, for a detailed description of these attributes refer to the corresponding IDN descriptions found in the SERCOS Interface standard or the AB SERCOS Drive PISD. Since these attributes are automatically configured to reasonable default values, manual configuration by the user is not required unless motivated by a specific application requirement.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Droop	REAL	Position Units / sec

Drive Limits

This section covers the various drive attributes that either apply limits to various servo loop real-time parameters, such as position and output voltage, or are used in limit checks of servo loop parameters like position error.

Maximum Positive/Negative Travel

The Axis Object provides configurable software travel limits via the Maximum Positive and Negative Travel attributes. If the axis is configured for software overtravel limit checking by setting the Soft Overtravel Bit in the Drive Configuration Bit word, and the axis passes outside these maximum travel limits, a Software Overtravel Fault is issued.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Maximum Positive Travel	REAL	Position Units
SSV/GSV	Maximum Negative Travel	REAL	Position Units

When software overtravel checking is enabled, appropriate values for the maximum travel in both the Maximum Positive and Maximum Negative Travel attributes need to be established with Maximum

Positive Travel always greater than Maximum Negative Travel. Both of these values are specified in the configured Position Units of the axis.

Note: The software travel limits are not enabled until the selected homing sequence is completed.

Position Error Tolerance

The Position Error Tolerance parameter specifies how much position error the drive tolerates before issuing a Position Error Fault. Like the position lock tolerance, the position error tolerance is interpreted as a ± quantity. For example, specifying a position error tolerance of 0.75 Position Units means that a Position Error Fault is generated whenever the position error of the axis is greater than 0.75 or less than -0.75 Position Units, as shown below:

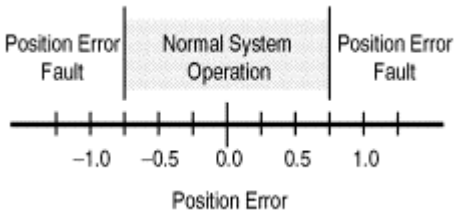


Figure 13.21 Position Error

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Error Tolerance	REAL	Position Units

The self tuning routine sets the position error tolerance to twice the following error at maximum speed based on the measured response of the axis. In most applications, this value provides reasonable protection in case of an axis fault or stall condition without nuisance faults during normal operation. If you need to change the calculated position error tolerance value, the recommended setting is 150% to 200% of the position error while the axis is running at its maximum speed.

Position Lock Tolerance

The Position Lock Tolerance attribute value specifies how much position error the SERCOS module tolerates when giving a true Position Locked Status indication. When used in conjunction with the Position Locked Status bit, it is a useful parameter to control positioning accuracy. The Position Lock Tolerance value should be set, in Position Units, to the desired positioning accuracy of the axis.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Lock Tolerance	REAL	Position Units

Note that the position lock tolerance value is interpreted as a ± quantity. For example, if your position units are Inches, specifying a position lock tolerance of 0.01 provides a minimum positioning accuracy of ±0.01 inches as shown below.

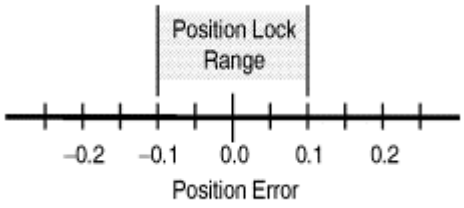


Figure 13.22 Position lock Range

Torque Limit

The Torque Limit attribute provides a method of limiting the maximum command current/torque to the motor to a specified level in terms of the motor's continuous current/torque rating. The output of the servo drive to the motor as a function of position servo error, both with and without servo torque limiting, is shown below.

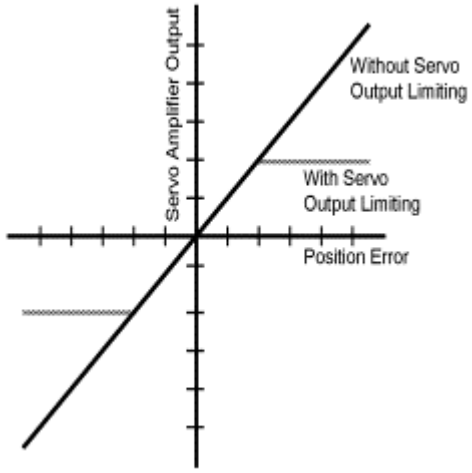


Figure 13.23 Torque Limit

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Torque Limit (Bipolar)	REAL	%Rated

The torque limit specifies the maximum percentage of the motors rated current that the drive can command as either positive or negative torque. For example, a torque limit of 150% shall limit the current delivered to the motor to 1.5 times the continuous current rating of the motor.

Continuous Torque Limit

The Torque limit attribute provides a method for controlling the continuous torque limit imposed by the drive's thermal model of the motor. Increasing the Continuous Torque Limit increases the amount of continuous motor torque allowed before the drive either folds back the motor current or the drive declares a motor thermal fault. Motors equipped with special cooling options can be configured with a Continuous Torque Limit of greater than 100% rated to attain higher continuous torque output from the motor. Motors operating in high ambient temperature conditions can be configured with a Continuous Torque Limit of less than 100% rated torque to protect the motor from overheating.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV?GSV	Continuous Torque Limit	REAL	%Rated

The Continuous Torque Limit specifies the maximum percentage of the motors rated current that the drive can command on a continuous or RMS basis. For example, a Continuous Torque Limit of 150% limits the continuous current delivered to the motor to 1.5 times the continuous current rating of the motor.

Advanced Drive Limits

The following advanced attributes map directly to SERCOS IDNs. Thus, for a detailed description of these attributes refer to the corresponding IDN descriptions found in the SERCOS Interface standard. Since these attributes are automatically configured to reasonable default values, manual configuration by the user is not required unless motivated by a specific application requirement.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Limit (Bipolar)	REAL	Position Units / sec
SSV/GSV	Acceleration Limit (Bipolar)	REAL	Position Units / sec^2
SSV/GSV	Velocity Limit (Positive)	REAL	Position Units / sec
SSV/GSV	Velocity Limit (Negative)	REAL	Position Units / sec
SSV/GSV	Velocity Threshold	REAL	Position Units / sec
SSV/GSV	Velocity Window	REAL	Position Units / sec
SSV/GSV	Velocity Standstill Window	REAL	Position Units / sec
SSV/GSV	Acceleration Limit (Pos.)	REAL	Position Units / sec^2
SSV/GSV	Acceleration Limit (Neg.)	REAL	Position Units / sec^2
SSV/GSV	Torque Limit (Positive)	REAL	%Rated
SSV/GSV	Torque Limit (Negative)	REAL	%Rated
SSV/GSV	Torque Threshold	REAL	%Rated

Drive Offsets

This section covers the various drive attributes that provide offsets to real-time servo drive loop operation.

Friction Compensation

It is not unusual for an axis to have enough static friction, so called "sticktion", that even with a significant position error, refuses to budge. Of course, integral gain can be used to generate enough output to the drive to correct the error, but this approach may not be responsive enough for the application. An alternative is to use Friction Compensation to break sticktion in the presence of a non-zero position error. This is done by adding, or subtracting, a fixed output level, called Friction Compensation, to the Servo Output value based on its current sign.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Friction Compensation	REAL	% Rated

The Friction Compensation value should be just under the value that would break the sticktion. A larger value results in the Axis to "dither", a phenomena describing a rapid back and forth motion of the axis centered on the commanded position.

Friction Compensation Window

To address the issue of dither when applying Friction Compensation and hunting from the integral gain, a Friction Compensation Window is applied around the current command position when the axis is not being commanded to move. If the actual position is within the Friction Compensation Window the Friction Compensation value is applied to the Servo Output but scaled by the ratio of the position error to the Friction Compensation Window. Within the window, the servo integrators are also disabled. Thus, once the position error reaches or exceeds the value of the Friction Compensation Window attribute, the full Friction Compensation value is applied. If the Friction Compensation Window is set to zero, this feature is effectively disabled.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Friction Compensation Window	REAL	Position Units

A non-zero Friction Compensation Window has the effect of softening the Friction Compensation as its applied to the Servo Output and reducing the dithering effect that it can create. This generally allows higher values of Friction Compensation to be applied. Hunting is also eliminated at the cost of a small steady-state error.

Velocity Offset

Velocity Offset compensation can be used to correct to provide a dynamic velocity correction to the output of the position servo loop. Since this value is updated synchronously every Coarse Update Period, the Velocity Offset can be tied into custom outer control loop algorithms using Function Block programming.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Offset	REAL	Position Units per sec

Torque Offset

Torque Offset compensation can be used to provide a dynamic torque command correction to the output of the velocity servo loop. Since this value is updated synchronously every Coarse Update Period, the Torque Offset can be tied into custom outer control loop algorithms using Function Block programming.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Torque Offset	REAL	% Rated

Backlash Reversal Error

Backlash Reversal Error provides the user the capability to compensate for positional inaccuracy introduced by mechanical backlash. For example, power-train type applications require a high level of accuracy and repeatability during machining operations. Axis motion is often generated by a number of mechanical components, a motor, a gearbox, and a ball-screw that may introduce inaccuracies and that are subject to wear over their lifetime. Hence, when an axis is commanded to reverse direction, mechanical play in the machine (through the gearing, ball-screw, etc.) may result in a small amount of motor motion without axis motion. As a result, the feedback device may indicate movement even though the axis has not physically moved.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Backlash Reversal Error	REAL	

Compensation for mechanical backlash can be achieved by adding a directional offset, specified by the Backlash Reversal Error attribute, to the motion planner's command position as it is applied to the associated servo loop. Whenever the commanded velocity changes sign (a reversal), the Logix controller adds, or subtracts, the Backlash Distance value from the current commanded position. This causes the servo to immediately move the motor to the other side of the backlash window and engage the load. It is important to note that the application of this directional offset is completely transparent to the user; the offset does not have any affect on the value of the Command Position attribute.

If a value of zero is applied to the Backlash Reversal Offset, the feature is effectively disabled. Once enabled by a non-zero value, and the load is engaged by a reversal of the commanded motion, changing the Backlash Reversal Offset can cause the axis to shift as the offset correction is applied to the command position.

Backlash Stabilization Window

The Backlash Stabilization Window attribute is used to control the Backlash Stabilization feature in the servo control loop. What follows is a description of this feature and the general backlash instability phenomenon.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Backlash Stabilization Window	REAL	

Mechanical backlash is a common problem in applications that utilize mechanical gearboxes. The problem stems from the fact that until the input gear is turned to the point where its proximal tooth contacts an adjacent tooth of the output gear, the reflected inertia of the output is not felt at the motor. In other words, when the gear teeth are not engaged, the system inertia is reduced to the motor inertia.

If the servo loop is tuned for peak performance with the load applied, the axis is at best under-damped and at worst unstable in the condition where the gear teeth are not engaged. In the worst case scenario, the motor axis and the input gear oscillates wildly between the limits imposed by the output gear teeth. The net effect is a loud buzzing sound when the axis is at rest. If this situation persists the gearbox wears out prematurely. To prevent this condition, the conventional approach is to de-tune the servo so that the axis is stable without the gearbox load applied. Unfortunately, system performance suffers."

With a Backlash Stabilization Window value commensurate with the amount of backlash in the mechanical system, the backlash stabilization algorithm is very effective in eliminating backlash induced instability while maintaining full system bandwidth. The key to this algorithm is a tapered Torque Scaling profile that is a function of the position error of the servo loop. The reason for the tapered profile as opposed to a step profile is that when the position error exceeds the backlash distance a step profile creates a very large discontinuity in the torque output. This repulsing torque tends to slam the axis back against the opposite gear tooth and perpetuate the buzzing effect. The tapered profile is only run when the acceleration command to the servo loop is zero, i.e. when no acceleration or deceleration is commanded to engage the teeth of the gearbox.

Properly configured with a suitable value for the Backlash Stabilization Window, this algorithm entirely eliminates the gearbox buzz without sacrificing any servo performance. The Backlash Stabilization parameter determines the width of the window over which backlash stabilization is applied. In general, this value should be set to the measured backlash distance. A Backlash Stabilization Window value of zero effectively disables the feature.

The Backlash Distance parameter determines the width of the window over which backlash compensation and backlash stabilization is applied.

Drive Fault Actions

Each axis can be configured to respond to each of the five types of drive faults in any one of four different ways. This flexibility is important because motion control applications differ widely in their fault action requirements.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Soft Overtravel Fault Action	SINT	Enumeration: 0 = shutdown 1 = disabled drive 2 = stop command 3 = status only
SSV/GSV	Hard Overtravel Fault Action	SINT	"
SSV/GSV	Position Error Fault Action	SINT	"
SSV/GSV	Feedback Fault Action	SINT	"
SSV/GSV	Feedback Noise Fault Action	SINT	"
SSV/GSV	Drive Thermal Fault Action	SINT	"
SSV/GSV	Motor Thermal Fault Action	SINT	"
SSV/GSV	Drive Enable Input Fault Action	SINT	"

Shutdown

If a fault action is set to Shutdown, then when the associated fault occurs, axis servo action is immediately disabled as is the drive power structure. Unless some external form of braking capability is applied the axis generally coasts to a stop. Shutdown is the most severe action to a fault and it is usually reserved for faults that could endanger the machine or the operator if power is not removed as quickly and completely as possible.

Disable Drive

If a fault action is set to Disable Drive, then when the associated fault occurs, the drive switches to local servo loop control and the axis is decelerated to a stop using the configured Stopping Torque. If the axis is not brought to a complete stop in the configured Stopping Time, both the servo action and the power structure are disabled.

Stop Command

If a fault action is set to Stop Command, then when the associated fault occurs, Logix control of the drive's ser4vo loop is maintained and the axis immediately starts decelerating the to a stop at the configured Maximum Deceleration rate without disabling the drive. This is the gentlest stopping mechanism in response to a fault. It is usually used for less severe faults, since it is relatively easy to recover from. Once the stop command fault action has stopped the axis, no further motion can be generated until the fault is first cleared. The only exception to this rule is in the case of the Hardware Overtravel and Software Overtravel faults, where we allow the axis to be jogged or moved off the limit.

Status Only

If a fault action is set to Status Only, then when the associated fault occurs motion faults must be handled by the application program. In general, this setting should *only* be used in applications where the standard fault actions are not appropriate.

The recommended setting of the fault action configuration parameters–suitable for most applications–are provided as defaults.

Warning: When setting a fault action of Stop Command or Status Only, the drive must remain enabled for the Logix controller to continue to control the axis. For example, in the case of Stop Command it is not possible for the Logix controller to bring the axis to a controlled stop when the axis is already disabled due to a drive fault. Similarly, selecting Status Only only allows motion to continue if the drive itself is still enabled and tracking the command reference.

Advanced Stop Action Attributes

The following advanced attributes map directly to SERCOS IDNs. Thus, for a detailed description of these attributes refer to the corresponding IDN descriptions found in the SERCOS Interface standard and the A-B SERCOS Drive PISD. Since these attributes are automatically configured based on the current Drive Configuration,

the user need not be concerned with manually configuring each of these attributes.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Stopping Torque	REAL	% Rated
SSV/GSV	Stopping Time Limit	REAL	Sec

Brake Engage Delay

The Brake Engage Delay attribute controls the amount of time that the drive continues to apply torque to the motor after the motor brake output is changed to engage the brake. This gives time for the motor brake to engage.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Brake Engage Delay Time	REAL	Sec

Below is the sequence of events associated with engaging the motor brake:

- Disable axis is initiated (via MSF or drive disable fault action)
- Drive stops tracking command reference, (Servo Action Status bit clears.)
- Decel to zero speed using configured Stopping Torque.
- Zero speed or Stopping Time Limit is reached.
- Turn motor brake output off to engage the motor brake.
- Wait Brake Engage Delay Time.
- Disable the drive power structure. (Drive Enable Status bit clears.)

If the axis is shutdown through either a fault action or motion instruction the drive power structure is disabled immediately and the motor brake is engaged immediately.

- Drive stops tracking command reference. (Servo Action Status bit clears.)
- Disable drive power structure, (Drive Enable Status bit clears.)
- Turn off brake output to engage brake.

Brake Release Delay

The Brake Release Delay attribute controls the amount of time that the drive holds of tracking command reference changes after the brake output is changed to release the brake. This gives time for the brake

to release. Below is the sequence of events associated with engaging the brake

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Brake Release Delay Time	REAL	Sec

- Enable axis is initiated (via MSO or MAH)
- Drive power structure enabled. (Drive Enable Status bit sets.)
- Turn motor brake output on to release the brake.**
- Wait Brake Release Delay Time.
- Track command reference. (Servo_Action_Status bit sets)

**The drive does not release the brake unless there is holding torque.

Resistive Brake Contact Delay

The Resistive Brake Contact Delay attribute is used to control an optional external Resistive Brake Module (RBM). The RBM sits between the drive and the motor and uses an internal contactor to switch the motor between the drive and a resisted load. This contactor is controlled by the dedicated RBM output of the drive.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Resistive Brake Contact Delay	REAL	Sec

When the drive's RBM output is energized, the RBM contactor is switched from the load resistors to the UVW motor lines connecting the drive to the motor. This switching does not occur instantaneously and enabling the power structure too early can cause electrical arcing across the contactor. The resistive brake contact delay is the time that it takes to fully close the contactor across the UVW motor lines. In order to prevent electrical arcing across the the contactor the enabling of the drive's power structure is delayed. The delay time is variable depending on the RBM model. When applying an RBM, the customer must set the Resistive Brake Contact Delay to the recommended value found in the RBM specification.

The following cases outline how the RBM output relates to the normal enable and disable sequences.

Case 1 – Enable Sequence:

1. Enable axis is initiated via MSO or MAH instruction.
2. Turn on RBM output to connect motor to drive.
3. Wait for Resistive Brake Contact Delay while RBM contacts close.

4. Drive power structure enabled (Drive Enable Status bit is set).
5. Turn on motor brake output to release brake.
6. Wait Brake Release Delay Time while motor brake releases.
7. Track Command reference (Servo Action Status bit is set).

Case 2 – Disable - Category 1 Stop

1. Disable axis is initiated via an MSF instruction or a drive disable fault action.
2. Drive stops tracking command reference (Servo Action Status bit is cleared).
3. Apply Stopping Torque to stop motor.
4. Wait for zero speed or Stopping Time Limit.
5. Turn off brake output to engage motor brake.
6. Wait for Brake Engage delay while motor brake engages.
7. Disable drive power structure (Drive Enable Status bit is cleared).
8. Turn off RBM output to disconnect motor from drive.

Case 3 – Shutdown Category 0 Stop

1. Drive stops tracking command reference (Servo Action Status bit is cleared).
2. Disable drive power structure (Drive Enable Status bit is cleared).
3. Turn off brake output to engage brake.
4. Turn off RBM output to disconnect motor from drive.

Drive Power Attributes

Two key drive configuration attributes are used to verify that the actual drive has the proper power supply and bus regulator hardware.

Power Supply ID

The Power Supply ID attribute contains the enumeration of the specific A-B Power Supply or System Module catalog numbers associated with the axis. If the Power Supply ID does not match that

of the actual supply hardware, an error is generated during the drive configuration process.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Power Supply ID	INT	

Bus Regulator ID

The Bus Regulator ID attribute contains the enumeration of the specific A-B Bus Regulator or System Shunt catalog numbers associated with the axis. If the Bus Regulator ID does not match that of the actual bus regulator or shunt hardware, an error is generated during the drive configuration process.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Bus Regulator ID	INT	

PWM Frequency Select

The PWM Frequency Select attribute controls the frequency of the pulse width modulated voltage applied to the motor by the drive's power structure. Higher PWM Frequency values reduce torque ripple and motor noise based on the motor's electrical time constant. Higher PWM frequencies, however, mean higher switching frequencies, which tends to produce more heat in the drive's power structure. So, for applications that have high torque demands, a lower PWM frequency would be more appropriate.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	PWM Frequency	SINT	Enumeration: 0 = low frequency (default) 1 = high frequency

Commissioning Configuration Attributes

The Axis Object provides sophisticated automatic test tuning instructions, which allow it to determine proper settings for the servo loop attributes for each axis. These include not only the polarities, the gains, and also the maximum acceleration, deceleration, and velocity parameters.

Usually, the servo loop parameters need only be tested and tuned once when the motion controller is first integrated into the machine or when the machine is being commissioned at start-up. However, if the load on any axis changes significantly or if the motor or drive amplifier is replaced for any reason, it may be necessary to re-test and re-tune the servo loop parameters.

The Commissioning Configuration Attributes shown in the table below are used to control the axis test and tuning processes that are initiated

by the MRHD and MRAT instructions. Therefore, these values should be established before the MRHD or MRAT instructions are executed.

Test Increment The Test Increment attribute is used in conjunction with the MRHD (Motion Run Hookup Diagnostic) instruction to determine the amount of motion that is necessary to satisfy the MRHD initiated test process. This value is typically set to approximately a quarter of a revolution of the motor.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Test Increment	REAL	Position Units

Tuning Travel Limit The Tuning Travel Limit attribute is used in conjunction with the MRAT (Motion Run Axis Tuning) instruction to limit the excursion of the axis during the test. If, while performing the tuning motion profile, the SERCOS module determines that the axis is not able to complete the tuning process before exceeding the Tuning Travel Limit, the SERCOS module terminates the tuning profile and report that the Tuning Travel Limit was exceeded via the Tune Status attribute. This does not mean that the Tuning Travel Limit was actually exceeded, but that had the tuning process gone to completion that the limit would have been exceeded.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Tuning Travel Limit	REAL	Position Units

Tuning Speed The Tuning Speed attribute value determines the maximum speed of the MRAT (Motion Run Axis Tune) initiated tuning motion profile. This attribute should be set to the desired maximum operating speed of the motor prior to running the MRAT instruction. The tuning procedure measures maximum acceleration and deceleration rates based on ramps to and from the Tuning Speed. The accuracy of the measured acceleration and deceleration capability is reduced by tuning at a speed other than the desired operating speed of the system.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Tuning Speed	REAL	Position Units / Sec

Tuning Torque The Tuning Torque attribute value determines the maximum torque of the MRAT (Motion Run Axis Tune) initiated tuning motion profile. This attribute should be set to the desired maximum safe torque level prior to running the MRAT instruction. The default value is 100%, which

yields the most accurate measure of the acceleration and deceleration capabilities of the system. In some cases a lower tuning torque limit value may be desirable to limit the stress on the mechanics during the tuning procedure. In this case the acceleration and deceleration capabilities of the system are extrapolated based on the ratio of the tuning torque to the maximum torque output of the system. Note that the extrapolation error increases as the Tuning Torque value decreases.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Tuning Torque	REAL	%

Damping Factor

The Damping Factor attribute value is used in calculating the maximum Position Servo Bandwidth (see below) during execution of the MRAT (Motion Run Axis Tune) instruction. In general the Damping Factor attribute controls the dynamic response of the drive axis. When gains are tuned using a small damping factor (like 0.7), a step response test performed on the axis would demonstrate under-damped behavior with velocity overshoot. A gain set generated using a larger damping factor, like 1.0, would produce a system step response that have no overshoot but have a significantly lower servo bandwidth. The default value for the Damping Factor of 0.8 should work fine for most applications.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Damping Factor	REAL	

Drive Model Time Constant

The value for the Drive Model Time Constant represents lumped model time constant for the drive's current loop used by the MRAT instruction to calculate the Maximum Velocity and Position Servo Bandwidth values. The Drive Model Time Constant is the sum of the drive's current loop time constant, the feedback sample period, and the time constant associated with the velocity feedback filter. This value is set to a default value when the axis is configured based on the specific drive amplifier and motor feedback selection. Since the bandwidth of the velocity feedback filter is determined by the resolution of the feedback device, the value for the Drive Model Time Constant is smaller when high resolution feedback devices are selected.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Drive Model Time Constant	REAL	Sec

Velocity Servo Bandwidth

The value for the Velocity Servo Bandwidth represents the unity gain bandwidth that is to be used to calculate the gains for a subsequent MAAT (Motion Apply Axis Tune) instruction. The unity gain bandwidth is the frequency beyond which the velocity servo is unable to provide any significant position disturbance correction. In general, within the constraints of a stable servo system, the higher the Velocity Servo Bandwidth is the better the dynamic performance of the system. A maximum value for the Velocity Servo Bandwidth is generated by the MRAT (Motion Run Axis Tune) instruction. Computing gains based on this maximum value via the MAAT instruction results in dynamic response in keeping with the current value of the Damping Factor described above. Alternatively, the responsiveness of the system can be "softened" by reducing the value of the Velocity Servo Bandwidth before executing the MAAT instruction.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Velocity Servo Bandwidth	REAL	Hertz

There are practical limitations to the maximum Velocity Servo Bandwidth for the velocity servo loop based on the drive system and the desired damping factor of the system, Z. Exceeding these limits could result in an unstable servo operation. These bandwidth limitations may be expressed as follows:

Max Velocity Servo Bandwidth (Hz) = 0.159 * 0.25 * $1/Z^2$ * 1/Drive Model Time Constant

The factor of 0.159 represents the 1/2PI factor required to convert Radians per Second units to Hertz.

Position Servo Bandwidth

The value for the Position Servo Bandwidth represents the unity gain bandwidth that is to be used to calculate the gains for a subsequent MAAT (Motion Apply Axis Tune) instruction. The unity gain bandwidth is the frequency beyond which the position servo is unable to provide any significant position disturbance correction. In general, within the constraints of a stable servo system, the higher the Position Servo Bandwidth the better the dynamic performance of the system. A maximum value for the Position Servo Bandwidth is generated by the MRAT (Motion Run Axis Tune) instruction. Computing gains based on this maximum value via the MAAT instruction result in dynamic responses in keeping with the current value of the Damping Factor described above Alternatively, the responsiveness of the system can

be “softened” by reducing the value of the Position Servo Bandwidth before executing the MAAT instruction.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Position Servo Bandwidth	REAL	Hertz

There are limitations to the maximum bandwidth that can be achieved for the position loop based on the dynamics of the inner velocity and current loops of the servo system and the desired damping of the system, Z. Exceeding these limits could result in an unstable system. These bandwidth limitations may be expressed as follows:

$$\text{Max Position Bandwidth (Hz)} = 0.25 * 1/Z^2 * \text{Velocity Bandwidth (Hz)}$$

For example, if the maximum bandwidth of the velocity servo loop is 40 Hz and the damping factor, Z, is 0.8, the maximum the maximum position bandwidth is 16 Hz. Based on these numbers the corresponding proportional gains for the loops can be computed.

Motor Inertia & Load Inertia Ratio

The Motor Inertia value represents the inertia of the motor without any load attached to the motor shaft in Torque Scaling units of %Rated / Pos Units per Sec^2. The Load Inertia Ratio attribute’s value represents the ratio of the load inertia to the motor inertia. Auto-tuning uses the Motor Inertia value to calculate the Load Inertia Ratio based on the following equation.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Motor Inertia	REAL	%Rated / Pos Units per Sec^2
SSV/GSV	Load Inertia Ratio	REAL	%Rated / Pos Units per Sec^2

Load Inertia Ratio = (Total Inertia - Motor Inertia) / Motor Inertia.

Total Inertia is directly measured by the auto-tuning algorithm and applied to the Torque Scaling attribute in units of %Rated / Pos Units per Sec^2.

If the Load Inertia Ratio value is known, the Motor Inertia value can also be used to calculate a suitable Torque Scaling value for the fully loaded motor without performing an auto-tune. The equation used by RSLogix5000 to calculate the Torque Scaling value is as follows:

Torque Scaling = (1 + Load Inertia Ratio) * Motor Inertia.

The value for Load Inertia may be automatically calculated using Rockwell's MotionBook program while the value for Motor Inertia is derived from the Motion database file based on the motor selection.

Tuning Configuration Bits

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
SSV/GSV	Tuning Configuration Bits	DINT	0: Tuning Direction Reverse 1: Tune Position Error Integrator 2: Tune Velocity Error Integrator 3: Tune Velocity Feedforward 4: Tune Acceleration Feedforward 5: Tune Output Low-Pass Filter 6: Bi-directional Tuning 7: Tune Friction Compensation 8: Tune Torque Offset 9-31: *Reserved*

Tuning Direction Reverse

The Tune Direction Reverse bit attribute determines the direction of the tuning motion profile initiated by the MRAT (Motion Run Axis Tune) instruction. If this bit is set (true), motion is initiated in the reverse (or negative) direction.

Tune Position Error Integrator

The Tune Position Error Integrator bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Position Integral Gain. If this bit is clear (false), the value for the Position Integral Gain is set to zero.

Tune Velocity Error Integrator

The Tune Velocity Error Integrator bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Velocity Integral Gain. If this bit is clear (false) the value for the Velocity Integral Gain is set to zero.

Tune Velocity Feedforward

The Tune Velocity Feedforward bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Velocity Feedforward Gain. If this bit is clear (false), the value for the Velocity Feedforward Gain is set to zero.

Tune Acceleration Feedforward

The Tune Acceleration Feedforward bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Acceleration Feedforward Gain. If this bit is clear (false) the value for the Acceleration Feedforward Gain is set to zero.

Tune Output Low-Pass Filter

The Tune Output Low-Pass Filter bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Output Filter Bandwidth. If this bit is clear (false) the value for the Output Filter Bandwidth is set to zero, which disables the filter.

Bi-directional Tuning

The Bi-directional Tuning bit attribute determines whether the tuning motion profile initiated by the MRAT (Motion Run Axis Tune) instruction is uni-directional or bi-directional. If this bit is set (true), the tuning motion profile is first initiated in specified tuning direction and then is repeated in the opposite direction. Information returned by the Bi-directional Tuning profile can be used to tune Friction Compensation and Torque Offset.

Tune Friction Compensation

The Tune Friction Compensation bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Friction Compensation Gain. This tuning configuration is only valid if configured for bi-directional tuning. If this bit is clear (false) the value for the Friction Compensation Gain is not be affected.

Tune Torque Offset

The Tune Torque Offset bit attribute determines whether or not the MAAT (Motion Apply Axis Tune) instruction calculates a value for the Torque Offset. This tuning configuration is only valid if configured for bi-directional tuning. If this bit is clear (false) the value for the Torque Offset will not be affected.

Motion Coordinate System Object

Introduction The specification applies to a Logix controller based object called the Coordinate System Object. Instances of this object are needed to

support coordinated motion control using Logix based servo controllers, drives, and other physical motion devices. Applicable Logix controllers are the ControlLogix and SoftLogix5000.

The Coordinate System Object is an CIP compliant object grouping motion axes to span any of the supported coordinate systems being added to the Logix controller family. This object is the target of the coordinated move instructions and in the future will specify the source and target systems for coordinate transformations. Creating a tag of data type COORDINATE_SYSTEM creates instances of this object.

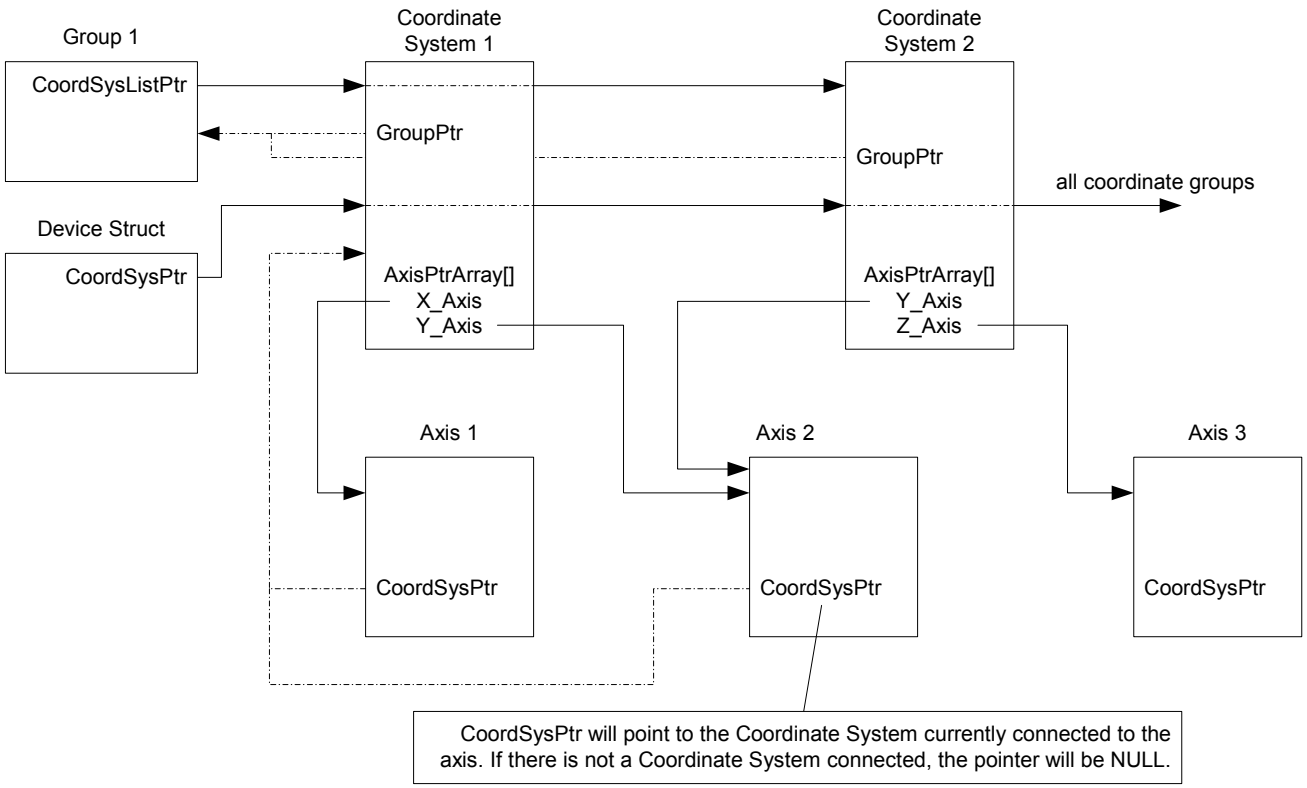
The Multi-Axis Coordination functionality provides the user with easy mechanisms for moving multiple axes of a Cartesian coordinate system in a coordinated fashion and in the future relating the axes of one coordinate system to the axes of another coordinate system. The interfaces to both mechanisms are simple instructions, which can be viewed as extensions to the already existing motion instructions.

RSLogix software must interface with Logix processor based motion related objects to affect motion behavior. This is done through CIP message based services or a User Program. The Motion Coordinate System Object is but one of many types of objects that are required to support coordinated motion within the Logix control architecture. The diagram below illustrates how this object relates to other motion objects within the Logix system.

Group, Axis and Coordinate System Relationships

The following diagram shows the relationship between existing Device, Motion Group, Axis objects and the new Motion Coordinate System object. Currently only one Motion Group instance is supported

per controller. The arrow labeled “all coordinate groups” would only apply if more than one Motion Group instance was supported.



The intent of the CoordSysPtr in the Axis Object is to provide a quick link to the Coordinate System currently using the axis for Axis Stop and Axis Shutdown processing.

Motion Coordinate System Object Status Attributes

The following sections define in more detail the behavior of the various status attributes associated with the Coordinate System Object. Status attributes are, by definition, read access only.

Motion Group Instance

The Motion Group Instance attribute is used to determine what motion group object instance this Motion Coordinate System is assigned to. The actual association of an instance of a Motion Coordinate System to a Motion group instance is done through a set attributes service of the group.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Motion Group Instance	DINT	Instance Number of Group assigned to Motion Coordinate System

Coordinate System Status

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
Tag	Coordinate System Status	DWORD	Direct Access Entire DINT – CoordinateSystemStatus 0: Shutdown Status -**ShutdownStatus** 1: Ready Status -**ReadyStatus** 2: MotionStatus -**MotionStatus** 3-31: *Reserved*

Shutdown Status

The Shutdown Status bit attribute is set if the coordinate system is in shutdown.

Ready Status

The Ready Status bit attribute is set if the coordinate system is in the ready state, i.e., ready to accept commanded coordinated motion.

Motion Status

The Motion Status bit attribute is set indicating that at least one Coordinate Motion instruction is active and the Coordinate System is connected to its associated axes.

Coordinate Motion Status

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
Tag	Coordinate Motion Status	DWORD	Direct Access Entire DINT – **CoordinateMotionStatus** 0: Acceleration Status **-AccelStatus** 1: Deceleration Status **-DecelStatus** 2: Actual Position Tolerance Status -ActualPosToleranceStatus 3: Command Position Tolerance Status **-CommandPosToleranceStatus** 4: Stopping Status **-StoppingStatus** 5: *Reserved* 6: Move Status **-MoveStatus** 7: Transition Status **-MoveTransitionStatus** 8: Move Pending Status **-MovePendingStatus** 9: Move Pending Queue Full Status **-MovePendingQueueFullStatus** 10-31: *Reserved*

Acceleration Status/ Deceleration Status

The Acceleration Status & Deceleration Status bit attributes can be used to determine if the coordinated (vectored) motion is currently being commanded to accelerate or decelerate.

Actual Position Tolerance Status

The Actual Position Tolerance Status bit attribute can be used to determine when a coordinate move is within the Actual Position Tolerance.

Command Position Tolerance Status

The Command Position Tolerance Status bit attribute can be used to determine when a coordinate move is within the Command Position Tolerance.

Stopping Status

The Stopping Status bit attribute is set if there is a coordinated stopping process currently in progress on this coordinated system.

Move Status

The Move Status attribute is set if a Coordinated Move motion profile is currently in progress. As soon as the Coordinated Move is complete or stopped the Move Status bit is cleared.

Move Transition Status

The Move Transition Status attribute is set any time the Coordinate Move motion profile transitions into a coordinate move.

Move Pending Status

The Move Pending Status bit attribute is set if a Coordinate Move motion profile currently has one or more pending coordinated moves.

Move Pending Queue Full Status

The Move Pending Queue Full Status attribute is set to indicate that the queue for pending coordinated moves is full and thus no more pending moves can be submitted.

Axis Fault The Axis Fault Bits attribute is a roll-up of all of the axes associated to this motion coordinate system. A bit being set indicates that one of the associated axes has that fault.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
Tag	Axis Fault	DWORD	Direct Access Entire DINT - **AxisFault** 0: Physical Axis Fault -**PhysicalAxisFault** 1: Module Fault - **ModuleFault** 2: Configuration Fault - **ConfigFault** 3-31: *Reserved*

Physical Axis Fault

If the Physical Axis Fault bit is set, it indicates that there is one or more fault conditions have been reported by the physical axis. The specific fault conditions can then be determined through access to the fault attributes of the associated physical axis.

Module Fault

The Module Fault bit attribute is set when a serious fault has occurred with the motion module associated with the selected axis. Usually a module fault affects all axes associated with the motion module. A module fault generally results in the shutdown of all associated axes. Reconfiguration of the motion module is required to recover from a module fault condition.

Configuration Fault

The Configuration Fault bit is set when an update operation targeting an axis configuration attribute of an associated motion module has failed. Specific information concerning the Configuration Fault may be found in the Attribute Error Code and Attribute Error ID attributes associated with the motion module.

Faulted / Shutdown / Servo On Axes

This collection of four attributes can be used to determine which associated axis has a specific fault, shutdown or servo on status. Bit 0 indicates axis 0 of the coordinate system has the specified condition, etc.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
Tag	Physical Axes Faulted	DWORD	Direct Access – **PhysicalAxesFaulted** Bit 0 = axis 0 . . Bit 7 – axis 7 Bits 8 – 31 Reserved
Tag	Modules Faulted	DWORD	Direct Access – **ModulesFaulted** Bit 0 = axis 0 . . Bit 7 – axis 7 Bits 8 – 31 Reserved

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
Tag	Axis Configuration Faulted	DWORD	Direct Access – **AxesConfigurationFaulted** Bit 0 = axis 0 . . Bit 7 – axis 7 Bits 8 – 31 Reserved
Tag	Axes Shutdown Status	DWORD	Direct Access – **AxesShutdownStatus** Bit 0 = axis 0 . . Bit 7 – axis 7 Bits 8 – 31 Reserved
Tag	Axes Servo On	DWORD	Direct Access – **AxesServoOnStatus** Bit 0 = axis 0 . . Bit 7 – axis 7 Bits 8 – 31 Reserved

Actual Position The Actual Position attribute gives the actual position of each associated axis in coordination unit.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values

Tag	Actual Position	Struct {
		UINT;
		REAL[n]
		}
			Array of actual positions in coordination units
			Struct {
			UINT length;
			REAL[] actual position;
			}
			Length range 1-8 – must be equal to Dimension.

Address of

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Address of	UDINT	Physical address of this instance of the object

Motion Coordinate System Configuration Attributes

The following sections define in more detail the behavior of all the various configuration attributes associated with the Coordinate System Object. The attributes, by definition, have read-write access. The Coordinate System Object Configuration Attributes are divided into three categories: Coordinate System General Configuration, Coordinate System Units and Coordinate System Dynamics attributes. These categories correspond roughly to the organization of the RSLogix 5000 Coordinate System Properties pages.

Coordinate System General Configuration Attributes

System Type This field displays the type of geometry associated with this coordinate system. For first release, the only choice is Cartesian. Future releases may contain Spherical, Polar, SCARA geometry for example.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	System Type	DINT	0 – unused 1 – Cartesian

Dimension This attribute configures the number of axes associated with this coordinate system

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Dimension	DINT	1-8 ****This attribute is settable ONLY as part of the create service.**

Axes The list of axes associated to this instance of the Motion Coordinate System.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Axes	STRUCT OF: UINT, ARRAY OF UDINT's	Struct { UINT length; UDINT[] – axis instance #s.} Length range 1-8 – must be equal to Dimension. Axes must be sent in the same order as the arrayed attributes are to be indexed.

Max Pending Moves The Max Pending Moves attribute is used to determine how many Move Pending queue slots should be created as part of the Coordinate System's create service.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV	Max Pending Moves	DINT	****This attribute is settable ONLY as part of the create service.** For first release this will limited to a queue of one.

Coordination Mode The Coordination Mode attribute configures which axes is used in velocity vector calculations, that being the 'primary' axes. The ancillary axes are ignored for the vector calculations.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Coordination Mode	Struct { UINT; SINT[n]}	Struct {length; mode[]} Length range 1-8– must be equal to Dimension. Enumeration of mode: 0 = Primary (default for axes 0, 1 & 2) 1 = Ancillary (default for all others)

Coordinate System Auto Tag Update The Coordinate System Auto Tag Update attribute configures whether the Actual Position attribute is automatically updated each motion task scan. This is similar to, but separate from the Motion Group's "Auto Tag Update" attribute.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV/SSV	Coordinate System Auto Tag Update	SINT	0 – auto update disabled 1 – auto update enabled (default)

Coordinate System Units Configuration

Coordination Units The Coordinate System Object allows user-defined engineering units rather than feedback counts to be used for measuring and programming all motion-related values (position, velocity, etc.). These coordination units can be different for each Coordinate System and should be chosen for maximum ease of use in your application.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
n/a	Coordination Units	STRING	Fixed length string of 32 characters with preceding length byte.

Conversion Ratio Conversion Ratio describes the ratio of axis position units to coordination units for each axis. Axis position units are defined in the Axis Properties page.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values

n/a	Conversion Ratio Numerator	Struct {
		UINT;
		REAL[n]
		}
			Struct {
			UINT length;
			REAL[] numerator;
			}
			Length range 1-8– must be equal to Dimension.

n/a	Conversion Ratio Denominator	Struct {
		UINT;
		DINT[n]
		}
			Struct {
			UINT length;
			DINT[] denominator;
			}
			Length range 1-8– must be equal to Dimension.

Coordinate System Dynamics Configuration

Maximum Speed The value of the Maximum Speed attribute is used by various motion instructions (e.g. MCLM, MCCM etc.) to determine the steady-state speed of the coordinate system vector when the speed is specified as a percent of the Maximum.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV/SSV	Maximum Speed	REAL	Coordination Units / Sec

Maximum Acceleration The Maximum Acceleration attribute value is used by motion instructions such as MCLM, MCCM etc., to determine the acceleration rate to apply to the coordinate system vector when the acceleration is specified as a percent of the Maximum.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV/SSV	Maximum Acceleration	REAL	Coordination Units / Sec^2

Maximum Deceleration The Maximum Deceleration attribute value is used by motion instructions such as MCLM, MCCM etc., to determine the deceleration

rate to apply to the coordinate system vector when the deceleration is specified as a percent of the Maximum.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV/SSV	Maximum Deceleration	REAL	Coordination Units / Sec^2

Actual Position Tolerance The Actual Position Tolerance attribute value is a distance unit used when instructions such as MCLM, MCCM etc. specify a Termination Type of Actual Position.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV/SSV	Actual Position Tolerance	REAL	Coordination Units

Command Position Tolerance The Command Position Tolerance attribute value is a distance unit used when instructions such as MCLM, MCCM etc. specify a Termination Type of Command Position.

Internal Access Rule	Attribute Name	Data Type	Semantics of Values
GSV/SSV	Command Position Tolerance	REAL	Coordination Units

Troubleshoot Module Lights

This chapter describes how to troubleshoot your ControlLogix motion control system using the LED indicators.

1756-M02AE LED Indicators

The module provides bi-colored LED indicators to show individual drive and feedback status for both axes and a single bi-colored LED for module OK.

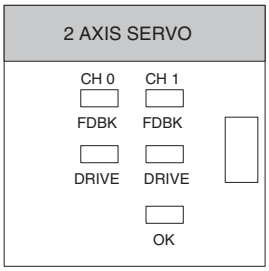


Figure 14.1 1756-M02AE Module LEDs

During power up, the module completes an indicator test. The OK indicator turns red for 1 second and then turns to flashing green if the module passes all its self tests.

1756-M02AE Module Status Using the OK Indicator

If the OK LED displays:	Then the module status is:	Take this action:
Off	The module is not operating.	• Apply chassis power. • Verify the module is completely inserted into the chassis and backplane.
Flashing green light	The module has passed internal diagnostics, but it is not communicating axis data over the backplane.	• None, if you have not configured the module. • If you have configured the module, check the slot number in the 1756-M02AE Properties dialog box.

If the OK LED displays:	Then the module status is:	Take this action:
Steady green light	• Axis data is being exchanged with the module. • The module is in the normal operating state.	None. The module is ready for action.
Flashing red light	• A major recoverable failure has occurred. • A communication fault, timer fault, or NVS update is in progress. • The OK contact has opened.	• Check the servo fault word for the source of the error. • Clear the fault condition using the motion instructions. • Resume normal operation. • If the flashing persists, reconfigure the module.
Solid red light	• A potential non-recoverable fault has occurred. • The OK contact has opened.	• Reboot the module. • If the solid red persists, replace the module.

1756-M02AE Module Status Using the FDBK Indicator

If the LED displays:	Then the module status is:	Take this action:
Off	The axis is not used.	• None, if you are not using this axis. • If you are using this axis, make sure you configured the module and associated an axis tag with the module.
Flashing green light	The axis is in the normal servo loop inactive state.	None. You can change the servo axis state by executing motion instructions.
Steady green light	The axis is in the normal servo loop active state.	None. You can change the servo axis state by executing motion instructions.
Flashing red light	The axis servo loop error tolerance has been exceeded.	• Correct the source of the problem. • Clear the servo fault using a fault reset instruction. • Resume normal operation.

If the LED displays:	Then the module status is:	Take this action:
Solid red light	An axis encoder feedback fault has occurred.	• Correct the source of the problem by checking the encoder and power connections. • Clear the servo fault using the MAFR instruction. • Resume normal operation.

1756-M02AE Module Status Using the DRIVE Indicator

If the LED displays:	Then the module status is:	Take this action:
Off	• The axis is not used. • The axis is a position-only axis type.	• None, if you are not using the axis or have configured it as a position-only axis. • Otherwise, make sure you have configured the module, associated an axis tag with the module, and configured the axis as a servo axis.
Flashing green light	The axis drive is in the normal disabled state.	None. You can change the servo axis state by executing a motion instruction.
Steady green light	The axis drive is in the normal enabled state.	None. You can change the servo axis state by executing a motion instruction.
Flashing red light	The axis drive output is in the Shutdown state.	• Check for faults that may have generated this state. • Execute the shutdown reset motion instruction. • Resume normal operation.

If the LED displays:	Then the module status is:	Take this action:

Solid red light	The axis drive is faulted.	• Check the drive status.
		• Clear the drive fault condition at the drive.
		• Execute a fault reset motion instruction.
		• Resume normal operation.
		• Check the configuration for the Drive Fault.
		  • If configured to be normally open and there is no voltage, this is the normal condition.
		  • If configured to be normally closed and there is 24V applied, this is the normal condition.

1756-M02AS LED Indicators

The module uses a single bi-colored LED to indicate module OK status and bi-colored LED indicators to show individual feedback (FDBK) and drive (DRIVE) status for both axes.

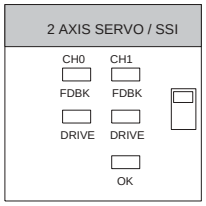


Figure 14.2 1756-M02AS Module LEDs

During power up, the module completes an indicator test. The OK indicator turns red for 1 second and then turns to flashing green if the module passes all its self tests.

1756-M02AS Module Status Using the OK Indicator

.

If the OK LED displays:	The module status is:	Take this action:
Off	The module is not operating.	Apply chassis power. Verify the module is completely inserted in chassis and backplane.

If the OK LED displays:	The module status is:	Take this action:
Flashing green light	The module has passed internal diagnostics, but it is not communicating axis data over the backplane.	None, if you have not configured the module. If you have configured the module, check the slot number in the 1756-M02AS Properties dialog box.
Steady green light	One of the following: Module is exchanging axis data. The module is in the normal operating state.	None
Flashing red light	One of the following: A major recoverable failure has occurred. A communication fault, timer fault, or non-volatile memory storage (NVS) update is in progress. The OK contact has opened.	If an NVS update is in progress, complete the NVS update. If an NVS update is not in progress: Check the Servo Fault word for the source of the error. Clear the servo fault condition via Motion Axis Fault Reset instruction. Resume normal operation. If the flashing persists, reconfigure the module.
Steady red light	One of the following: A potential non- recoverable fault has occurred. The OK contact has opened.	Reboot the module. If the solid red persists, replace the module.

1756-M02AS Module Status Using the FDBK Indicator

If the FDBK LED displays:	The module status is:	Take this action:
Off	The axis is not used.	None, if you are not using this axis. If you are using this axis, make sure the module is configured and an axis tag has been associated with the module.
Flashing green light	The axis is in the normal servo loop inactive state.	None. The servo axis state can be changed by executing motion instructions.
Steady green light	The axis is in the normal servo loop active state.	None. The servo axis state can be changed by executing motion instructions.

If the FDBK LED displays:	The module status is:	Take this action:
Flashing red light	The axis servo loop error tolerance has been exceeded.	Correct the source of the problem. Clear the servo fault condition using the Motion Axis Fault Reset instruction. Resume normal operation.
Steady red light	An axis SSI feedback fault has occurred.	Correct the source of the problem by checking the SSI device and power connections. Clear the servo fault condition using the Motion Axis Fault Reset instruction. Resume normal operation.

1756-M02AS Module Status Using the DRIVE Indicator

.

If the DRIVE LED displays:	The module status is:	Take this action:
Off	One of the following: The axis is not used. The axis is a position- only axis type.	None, if the axis is not used or is a position- only type. Otherwise, make sure the module is configured, an axis tag has been associated with the module, and the axis type is servo.
Flashing green light	The axis drive is in the normal disabled state.	None. The servo axis state can be changed by executing motion instructions.
Steady green light	The axis drive is in the normal enabled state.	None. The servo axis state can be changed by executing motion instructions.

If the DRIVE LED displays:	The module status is:	Take this action:
Flashing red light	The axis drive output is in the shutdown state.	Check for faults that may have generated this state. Execute the Motion Axis Shutdown Reset instruction. Resume normal operation.
Steady red light	The axis drive is faulted.	Check the drive status. Clear the Drive Fault condition at the drive. Clear the servo fault condition using the Motion Axis Fault Reset instruction. Resume normal operation. Check the configuration for the Drive Fault. If configured to be normally open and there is no voltage, this is the normal condition. If configured to be normally closed and 24V dc is applied, this is the normal condition.

1756-HYD02 Module LED Indicators

The module uses a single bi-colored LED to indicate module OK status and bi-colored LED indicators to show individual feedback (FDBK) and drive (DRIVE) status for both axes.**r**

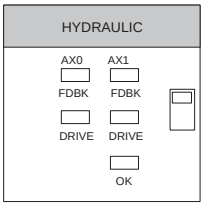


Figure 14.3 1756-HYD02 Module LEDs

During power up, the module completes an indicator test. The OK indicator turns red for 1 second and then turns to flashing green if the module passes all its self tests.

1756-HYD02 Module Status Using the OK Indicator

.

If the OK indicator displays:	The module status is:	Take this action:
Off	The module is not operating.	Apply chassis power. Verify the module is completely inserted in chassis and backplane.

If the OK indicator displays:	The module status is:	Take this action:
Flashing green light	The module has passed internal diagnostics, but it is not communicating axis data over the backplane.	None, if you have not configured the module. If you have configured the module, check the slot number in the 1756-HYD02 Properties dialog box.
Steady green light	One of the following: Module is exchanging axis data. The module is in the normal operating state.	None
Flashing red light	One of the following: A major recoverable failure has occurred. A communication fault, timer fault, or non-volatile memory storage (NVS) update is in progress. The OK contact has opened.	If an NVS update is in progress, complete the NVS update. If an NVS update is not in progress: Check the Servo Fault word for the source of the error. Clear the servo fault condition via Motion Axis Fault Reset instruction. Resume normal operation. If the flashing persists, reconfigure the module.
Steady red light	One of the following: A potential non- recoverable fault has occurred. The OK contact has opened.	Reboot the module. If the solid red persists, replace the module.

1756-HYD02 Module Status Using the FDBK Indicator

.

If the FDBK indicator displays:	The module status is:	Take this action:
Off	**The axis is not used.**	**None, if you are not using this axis.** **If you are using this axis, make sure the module is configured and an axis tag has been associated with the module.**
Flashing green light	**The axis is in the normal servo loop inactive state.**	**None. The servo axis state can be changed by executing motion instructions.**
Steady green light	**The axis is in the normal servo loop active state.**	**None. The servo axis state can be changed by executing motion instructions.**

If the FDBK indicator displays:	The module status is:	Take this action:
Flashing red light	**The axis servo loop error tolerance has been exceeded.**	**Correct the source of the problem.** **Clear the servo fault condition using the Motion Axis Fault Reset instruction.** **Resume normal operation.**
Steady red light	**An axis LDT feedback fault has occurred.**	**Correct the source of the problem by checking the LDT and power connections.** **Clear the servo fault condition using the Motion Axis Fault Reset instruction.** **Resume normal operation.**

1756-HYD02 Module Status Using the DRIVE Indicator

If the DRIVE indicator displays:	The module status is:	Take this action:
Off	One of the following: The axis is not used. The axis is a position- only axis type.	None, if the axis is not used or is a position- only type. Otherwise, make sure the module is configured, an axis tag has been associated with the module, and the axis type is servo.
Flashing green light	The axis drive is in the normal disabled state.	None. The servo axis state can be changed by executing motion instructions.
Steady green light	The axis drive is in the normal enabled state.	None. The servo axis state can be changed by executing motion instructions.

If the DRIVE indicator displays:	The module status is:	Take this action:
Flashing red light	The axis drive output is in the shutdown state.	Check for faults that may have generated this state. Execute the Shutdown Reset motion instruction. Resume normal operation.
Steady red light	The axis drive is faulted.	Check the drive status. Clear the Drive Fault condition at the drive. Clear the servo fault condition using the Motion Axis Fault Reset instruction. Resume normal operation. Check the configuration for the Drive Fault. If configured to be normally open and there is no voltage, this is the normal condition. If configured to be normally closed and 24V dc is applied, this is the normal condition.

SERCOS interface LED Indicators

The module provides three LED indicators to show the state of the system. The LEDs are located on the bezel of the 1756-M08SE and 1756-M16SE modules. The LED on the right, marked by OK, indicates the present health of the module and the communication status. To the immediate left of the OK LED is the SERCOS Ring LED. This is marked with a ring icon and displays the status of the SERCOS network. A third LED is situated on the far left and displays the status of the SERCOS Communication Phases. The CP LED is for informational purposes only.

The following diagram shows the positioning of the LEDs.

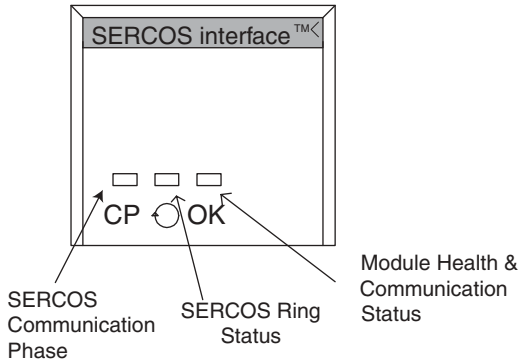


Figure 14.4 LED Location and Description

During power up, the module completes a self test that includes an indicator test. All LEDs go red for one second, green for one second, and off for one second.

1756-M03SE, -M08SE, & -M16SE SERCOS Communication Phase Status Using the CP Indicator

If the CP LED displays:	Then the module status is:
Solid Orange light	• In Phase -1: Autobaud detection in progress.
OFF	• In Phase 0: looking for a closed ring.
Flashing Red light	• In Phase 1: looking for active nodes.
Alternating Red/Green light	In Phase 2: configuring nodes for communication.
Flashing Green light	In Phase 3: configuring device specific parameters
Solid Green light	In Phase 4: configured and active.

1756-M03SE, -M08SE, & -M16SE Module Status Using the OK Indicator

If the OK LED displays:	Then the module status is:	Take this action:
Off	The module is not operating.	• Apply chassis power. • Verify the module is completely inserted into the chassis and backplane.
Flashing green light	The module has passed internal diagnostics, but has not established active communications.	• None, if you have not configured the module.
Solid green light	• Data is being exchanged. • The module is in the normal operating state.	None. The module is ready for action.
Flashing red light	• A major recoverable failure has occurred. • An NVS update is in progress.	If an NVS update is in progress, complete the NVS update. If an NVS update is not in progress: Reboot
Solid red light	A potential nonrecoverable fault has occurred.	• Reboot the module. • If the solid red persists, replace the module.

1756-M03SE, -M08SE, & -M16SE SERCOS Ring Status

If the SERCOS Ring LED displays:	Then the ring status is:	Take this action:
Solid green light	The ring, drive, and axes are configured and are actively communicating through to the nodes on the ring.	None.
Flashing red light	The module has detected a setup or configuration fault with the ring.	Check your system setup and configuration as follows:. • Ensure drive and axes addresses are correct. • Remove excess axes from ring. • Make sure application program has selected the proper Ring Cycle Period and Baud Rate.
Solid red light	The module has detected a hardware or installation fault with the ring.	Check your system hardware and installation as follows: • Make sure all cables are properly installed. • Make sure cable is of the correct type and length. • Make sure application program has configured the module's ring transmit level to High when using specified cables. • Make sure the drive's transmit levels are set appropriately. • Inspect cables for degradation. • Inspect drives for any faults and correct them.
Off	The module has detected no ring data on its receiver or has not successfully completed phase 2.	Check your system and installation as follows: • Make sure all cables are properly installed • Inspect cable for degradation and breakage. • Inspect drives for faults.
Flashing green light	The ring, drive, or axes are not configured but, at least one has been identified.	Not a problem if the system has not been configured. If you are having trouble configuring the ring, drive, and axes: Make sure that the application program is setup properly for the equipment in use.

Troubleshoot Axis Motion

About this chapter

This chapter helps you troubleshoot some situations that could happen while you are running an axis.

Situation	See page
Why does my axis accelerate when I stop it?	15-1
Why does my axis overshoot its target speed?	15-3
Why is there a delay when I stop and then restart a jog?	15-6
Why does my axis reverse direction when I stop and start it?	15-8

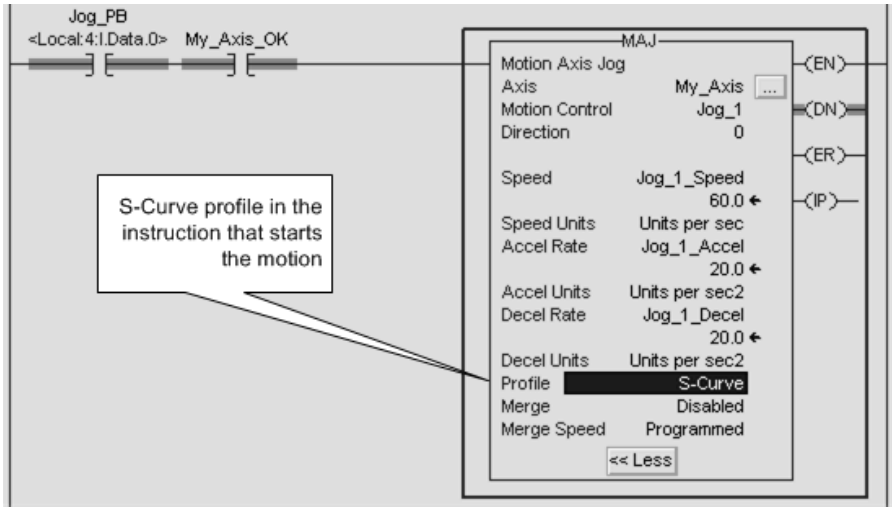
Why does my axis accelerate when I stop it?

While an axis is accelerating, you try to stop it. The axis keeps accelerating for a short time before it starts to decelerate.

Example

You start a Motion Axis Jog (MAJ) instruction. Before the axis gets to its target speed, you start a Motion Axis Stop (MAS) instruction. The axis continues to speed up and then eventually slows to a stop.

Look for



Cause

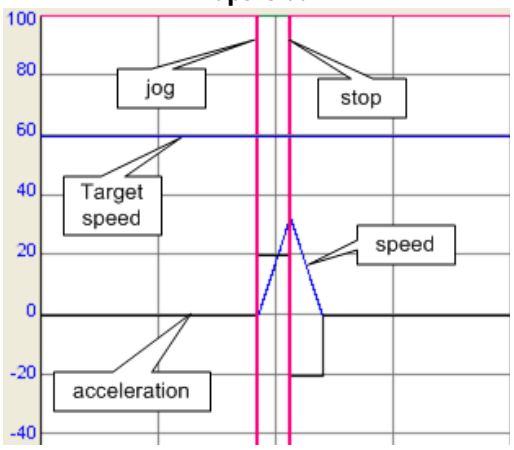
When you use an S-Curve profile, jerk determines the acceleration and deceleration time of the axis.

- An S-Curve profile has to get acceleration to 0 before the axis can slow down.
- The time it takes depends on the acceleration and speed.
- In the meantime, the axis continues to speed up.

The following trends show how the axis stops with a trapezoidal profile and an S-Curve profile.

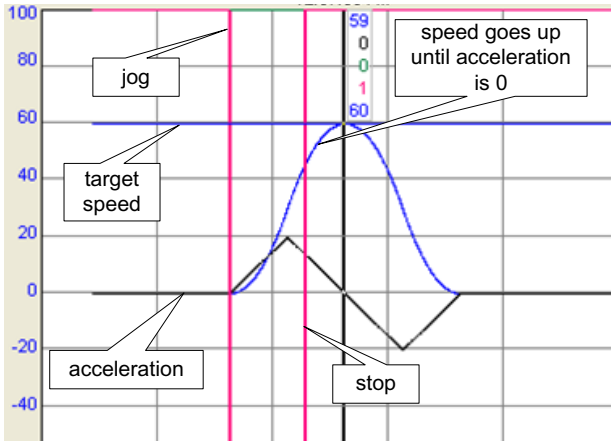
Stop while accelerating

Trapezoidal



The axis slows down as soon as you start the stopping instruction.

S-Curve



The axis continues to speed up until the S-Curve profile brings the acceleration rate to 0.

Corrective action

If you want the axis to slow down right away, use a trapezoidal profile.

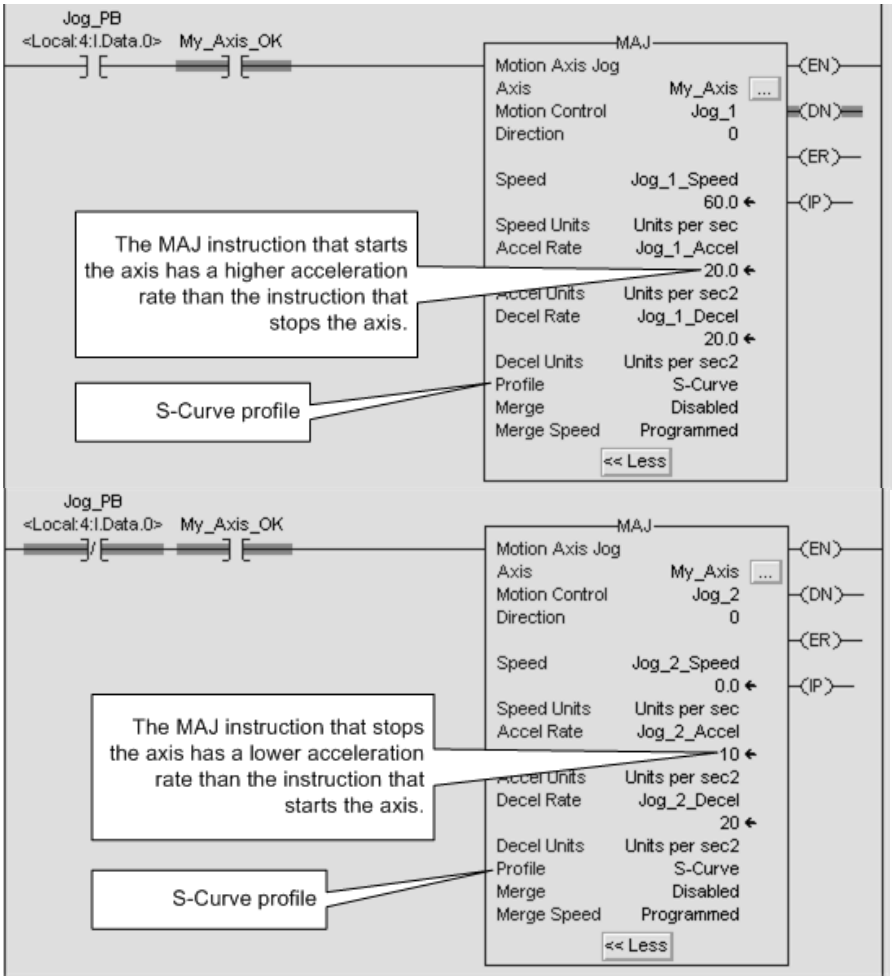
Why does my axis overshoot its target speed?

While an axis is accelerating, you try to stop the axis or change its speed. The axis keeps accelerating and goes past its initial target speed. Eventually it starts to decelerate.

Example

You start a Motion Axis Jog (MAJ) instruction. Before the axis gets to its target speed, you try to stop it with another MAJ instruction. The speed of the second instruction is set to 0. The axis continues to speed up and overshoots its initial target speed. Eventually it slows to a stop.

Look for



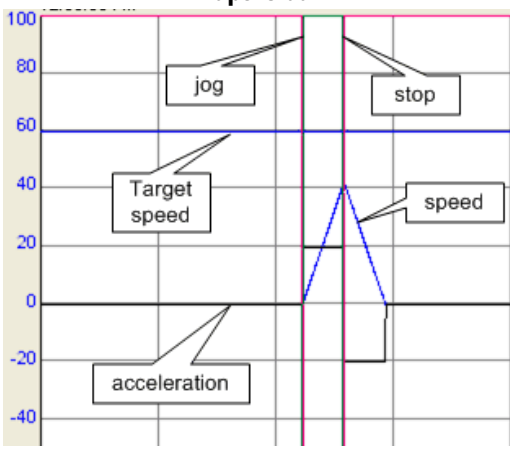
Cause When you use an S-Curve profile, jerk determines the acceleration and deceleration time of the axis.

- An S-Curve profile has to get acceleration to 0 before the axis can slow down.
- If you reduce the acceleration, it takes longer to get acceleration to 0.
- In the meantime, the axis continues past it's initial target speed.

The following trends show how the axis stops with a trapezoidal profile and an S-Curve profile.

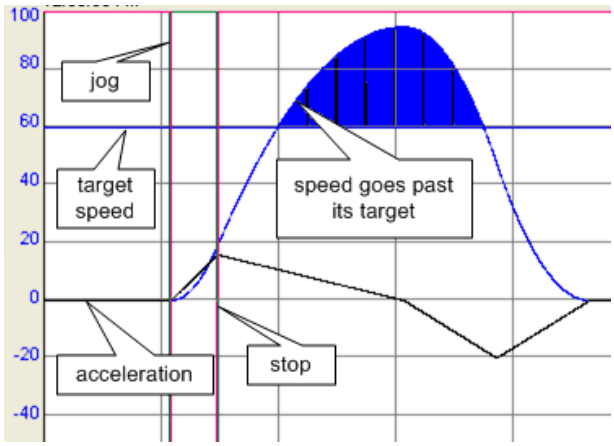
Stop while accelerating and reduce the acceleration rate

Trapezoidal



The axis slows down as soon as you start the stopping instruction. The lower acceleration doesn't change the response of the axis.

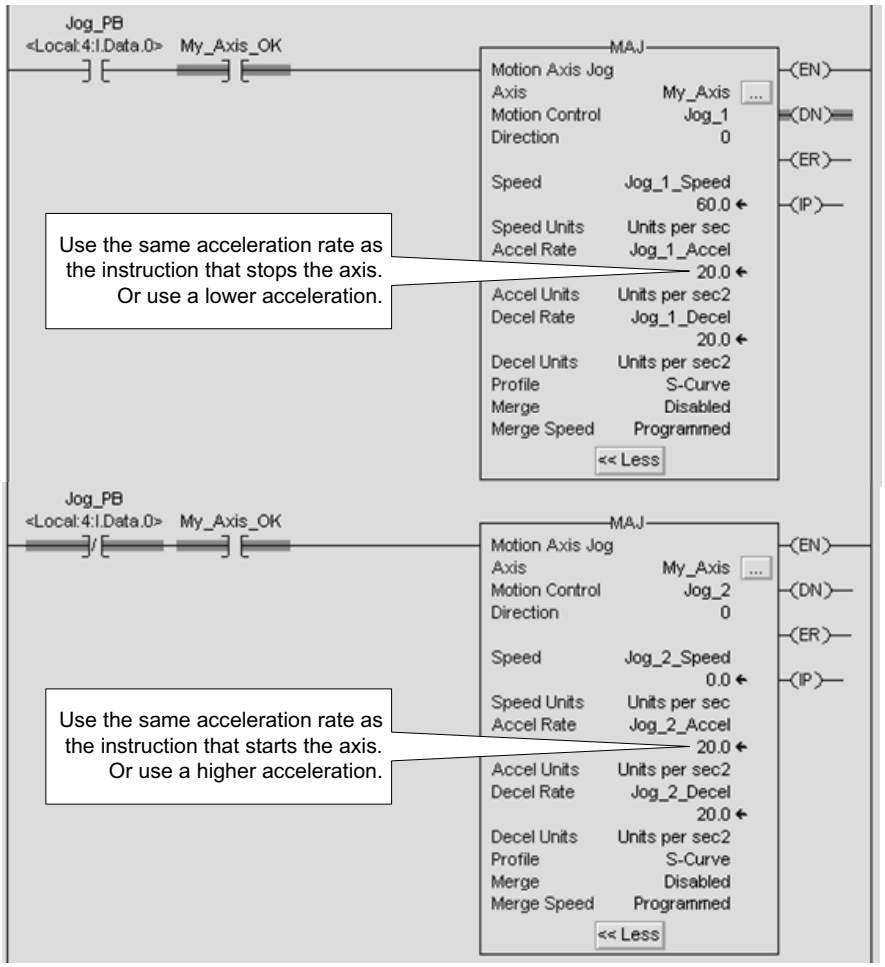
S-Curve



The stopping instruction reduces the acceleration of the axis. It now takes longer to bring the acceleration rate to 0. The axis continues past its target speed until acceleration equals 0.

Corrective action Use a Motion Axis Stop (MAS) instruction to stop the axis.

Or set up your instructions like this:



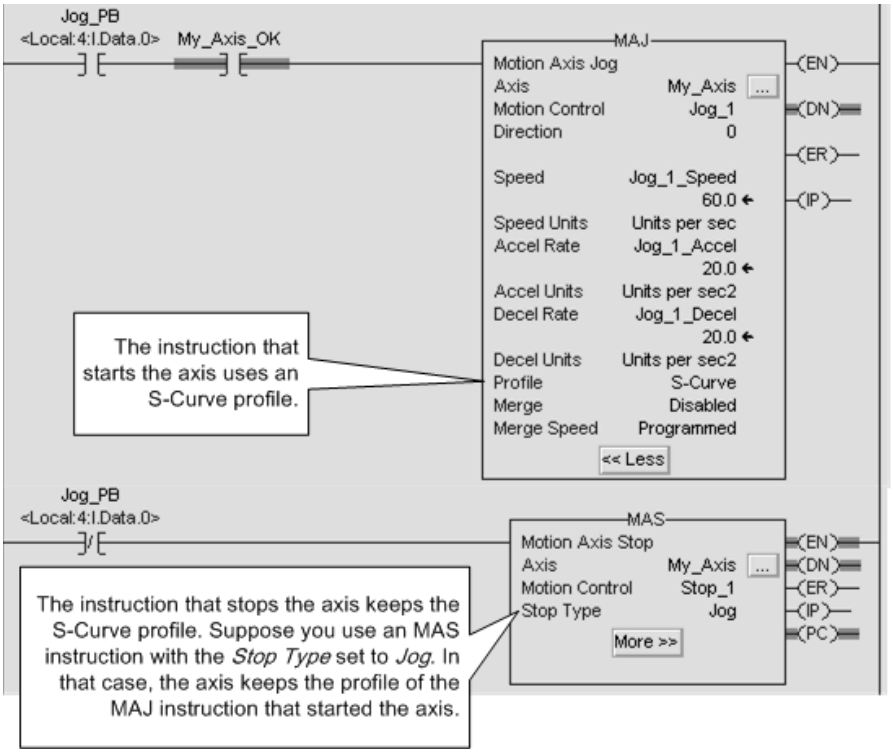
Why is there a delay when I stop and then restart a jog?

While an axis is jogging at its target speed, you stop the axis. Before the axis stops completely, you restart the jog. The axis continues to slow down before it speeds up.

Example

You use a Motion Axis Stop (MAS) instruction to stop a jog. While the axis is slowing down, you use a Motion Axis Jog (MAJ) instruction to start the axis again. The axis doesn't respond right away. It continues to slow down. Eventually it speeds back up to the target speed.

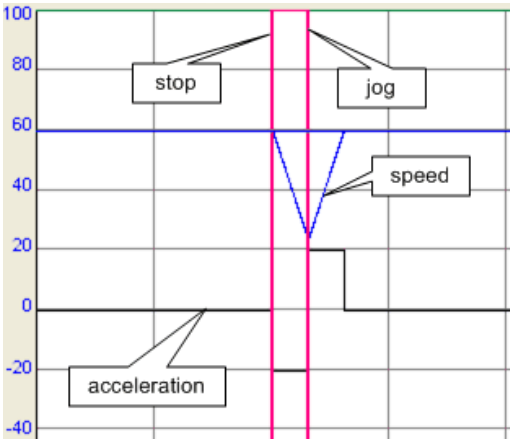
Look for



Cause When you use an S-Curve profile, jerk determines the acceleration and deceleration time of the axis. An S-Curve profile has to get acceleration to 0 before the axis can speed up again. The following trends show how the axis stops and starts with a trapezoidal profile and an S-Curve profile.

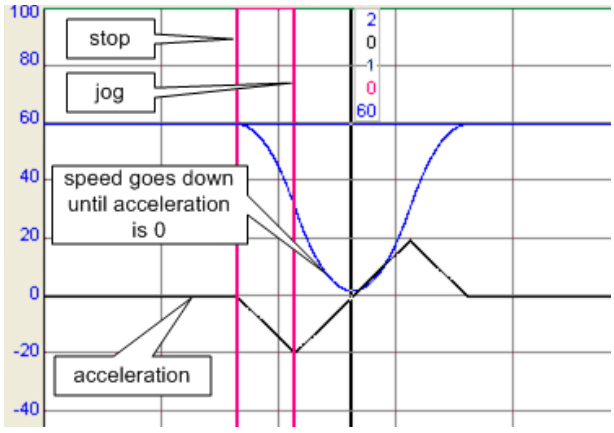
Start while decelerating

Trapezoidal



The axis speeds back up as soon as you start the jog again.

S-Curve



The axis continues to slow down until the S-Curve profile brings the acceleration rate to 0.

Corrective action If you want the axis to accelerate right away, use a trapezoidal profile.

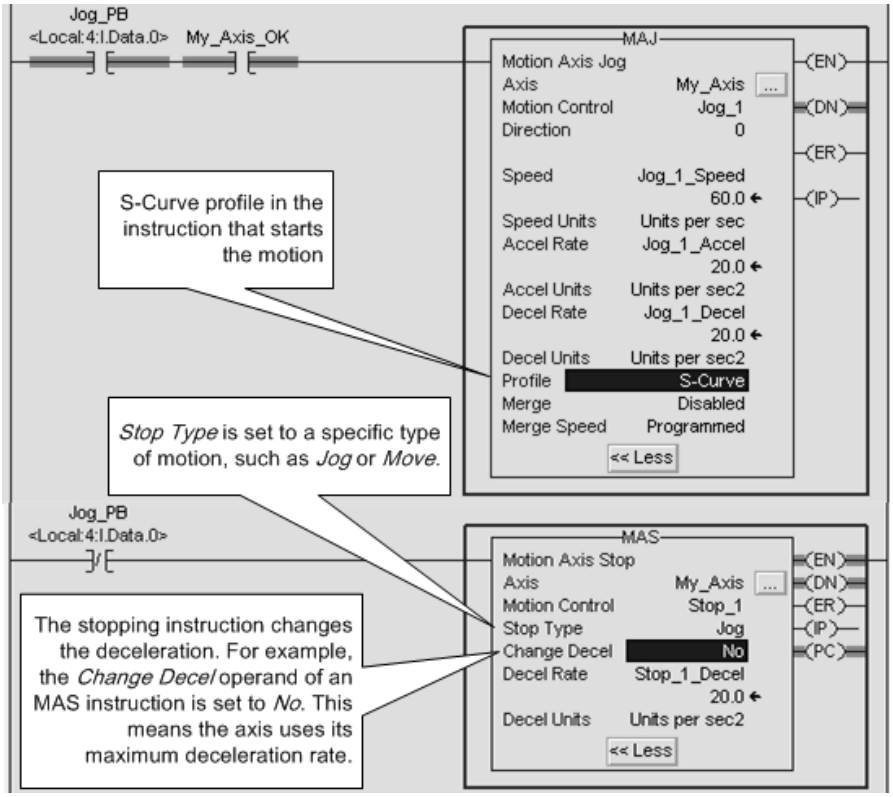
Why does my axis reverse direction when I stop and start it?

While an axis is jogging at its target speed, you stop the axis. Before the axis stops completely, you restart the jog. The axis continues to slow down and then reverse direction. Eventually the axis changes direction again and moves in the programmed direction.

Example

You use a Motion Axis Stop (MAS) instruction to stop a jog. While the axis is slowing down, you use a Motion Axis Jog (MAJ) instruction to start the axis again. The axis continues to slow down and then moves in the opposite direction. Eventually goes back to its programmed direction.

Look for



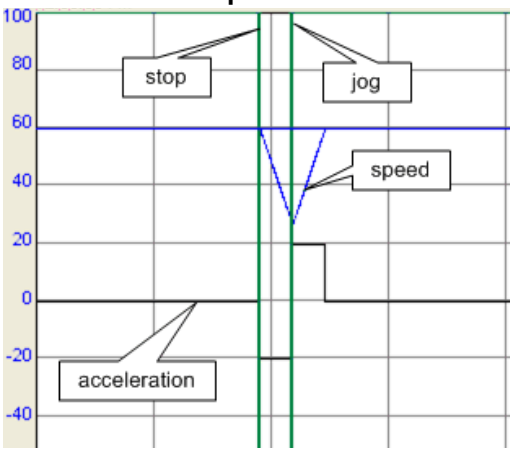
Cause When you use an S-Curve profile, jerk determines the acceleration and deceleration time of the axis.

- An S-Curve profile has to get acceleration to 0 before the axis can speed up again.
- If you reduce the acceleration, it takes longer to get acceleration to 0.
- In the meantime, the axis continues past 0 speed and moves in the opposite direction.

The following trends show how the axis stops and starts with a trapezoidal profile and an S-Curve profile.

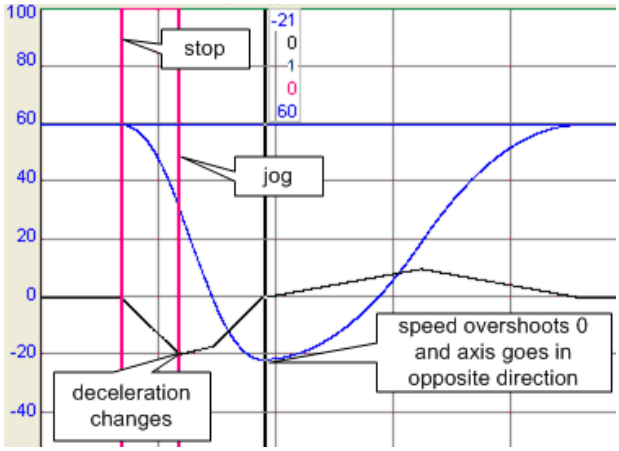
Start while decelerating and reduce the deceleration rate

Trapezoidal



The axis speeds back up as soon as you start the jog again. The lower deceleration doesn't change the response of the axis.

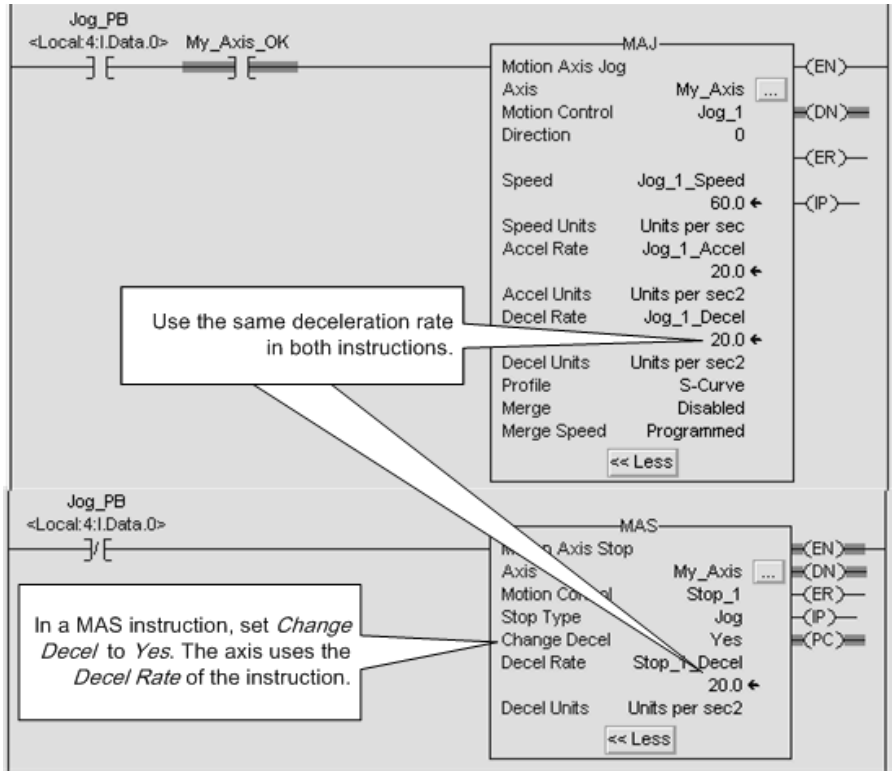
S-Curve



The jog instruction reduces the deceleration of the axis. It now takes longer to bring the acceleration rate to 0. The speed overshoots 0 and the axis moves in the opposite direction.

Corrective action

Use the same deceleration rate in the instruction that starts the axis and the instruction that stops the axis.



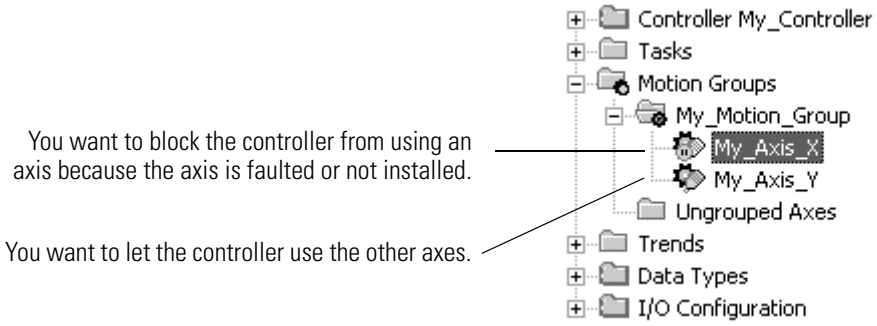
Inhibit an Axis

Purpose

To block the controller from using an axis

When

Inhibit an axis when:



Example 1

Suppose you make equipment that has between 8 and 12 axes, depending on which options your customer buys. In that case, set up one project for all 12 axes. When you install the equipment for a customer, inhibit those axes that the customer didn't buy.

Example 2

Suppose you have 2 production lines that use the same SERCOS ring. And suppose one of the lines gets a fault. In that case, inhibit the axes on that line. This lets you run the other line while you take care of the fault.

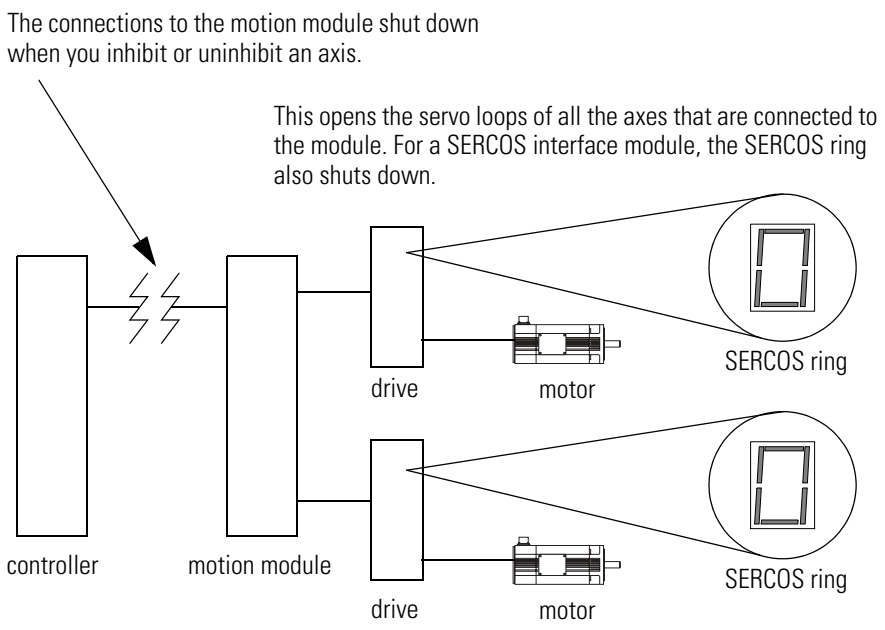
Before You Begin

Before you inhibit or uninhibit an axis, turn off all the axes.

Before you inhibit or uninhibit an axis:

1. Stop all motion.
2. Open the servo loops of all the axes. Use an instruction such as the Motion Servo Off (MSF) instruction.

This lets you stop motion under your control. Otherwise the axes turn off on their own when you inhibit or uninhibit one of them.


The connections to the motion module shut down when you inhibit or uninhibit an axis.
This opens the servo loops of all the axes that are connected to the module. For a SERCOS interface module, the SERCOS ring also shuts down.
SERCOS ring
drive
motor
controller
motion module
drive
motor
SERCOS ring

The controller automatically restarts the connections. The SERCOS ring also phases back up.

Inhibit only certain types of axes.

You can inhibit only these types of axes:

- AXIS_SERVO
- AXIS_SERVO_DRIVE
- AXIS_GENERIC_DRIVE

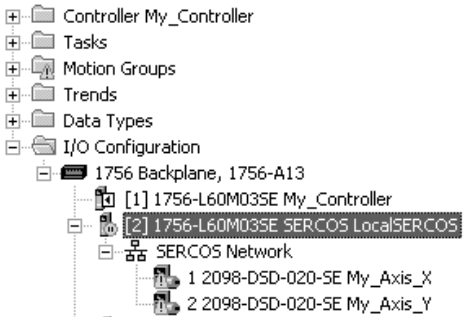
To inhibit all the axes of a motion module, inhibit the module instead.

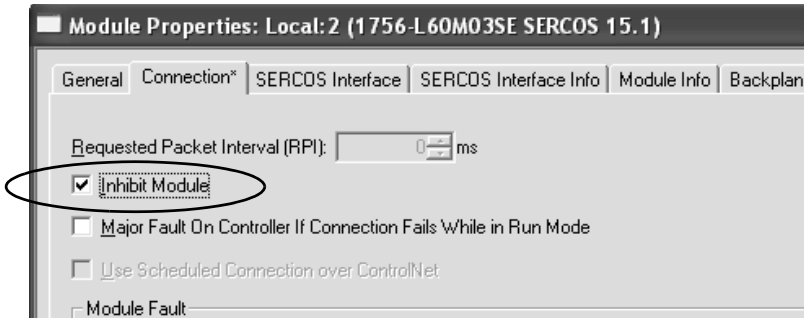
Do you want to inhibit all the axes of a motion module?

- YES — Inhibit the motion module instead.
- NO — Inhibit the individual axes.

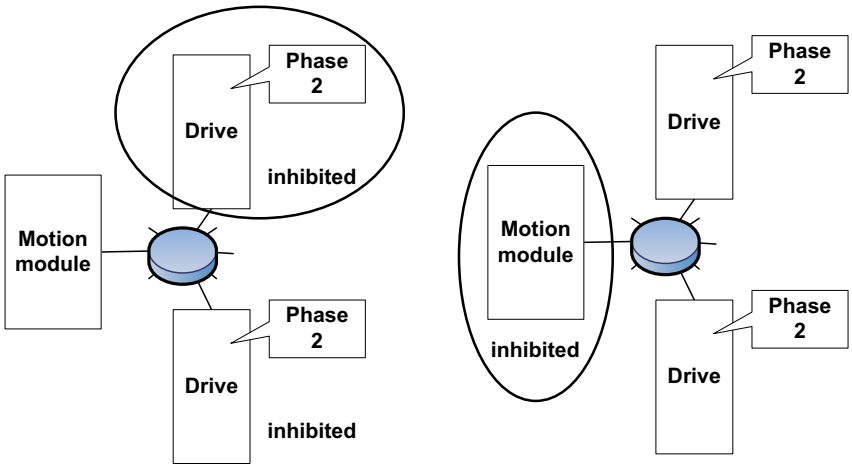
It's OK to inhibit all the axes of a module one-by-one. It's just easier to inhibit the module.

Example: Suppose your motion module has 2 axes and you want to inhibit both of those axes. In that case, just inhibit the module.

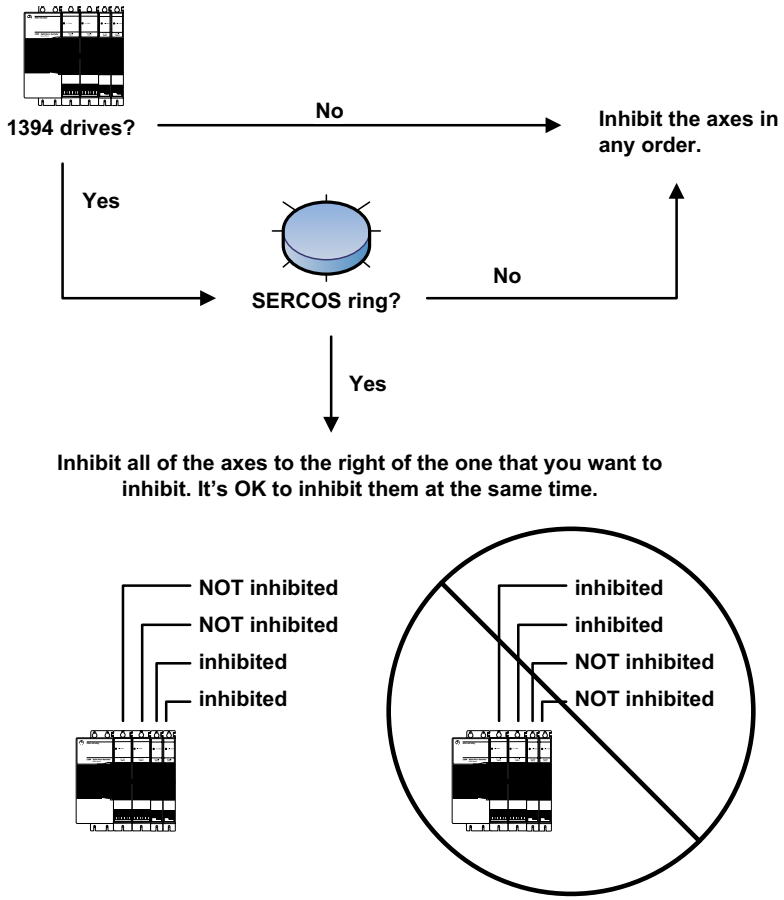




If you inhibit all of the axes on a SERCOS ring, the drives phase up to phase 2. This happens whether you inhibit all the axis individually or you inhibit the motion module.

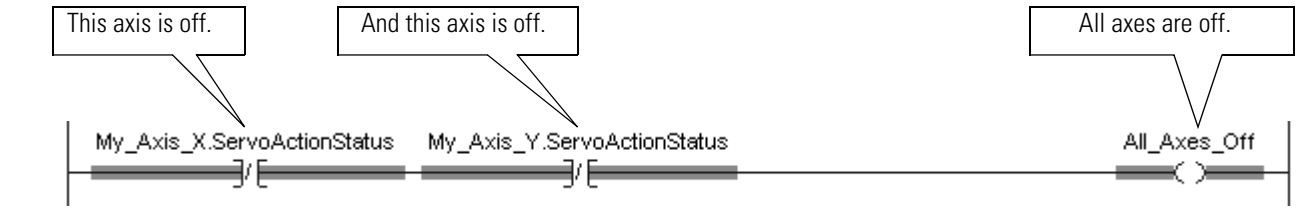


Do you have 1394 drives on a SERCOS ring?

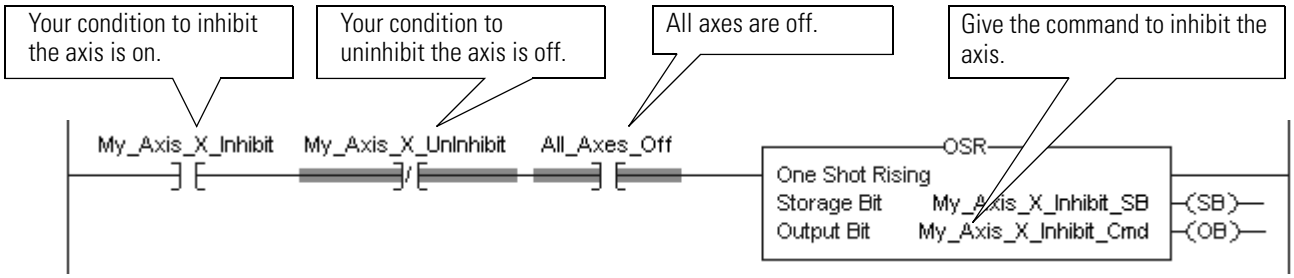


Example: Inhibit an Axis

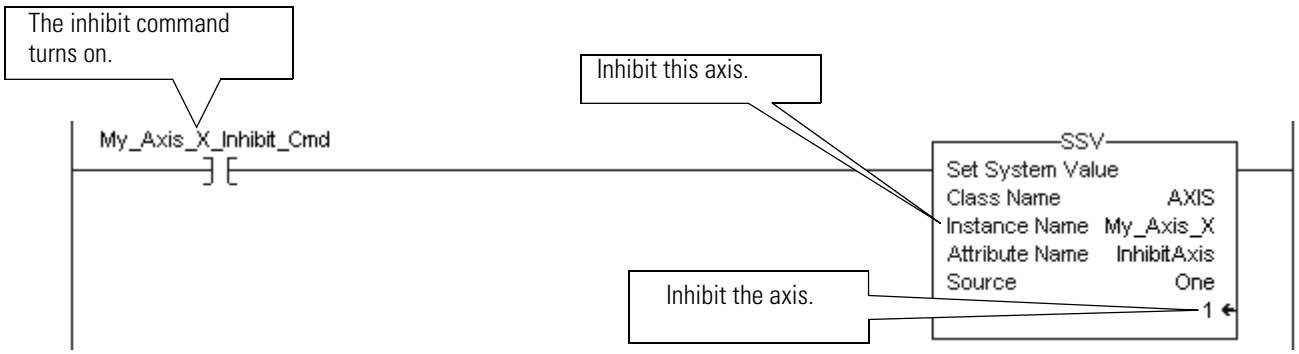
1. Make sure all exes are off.



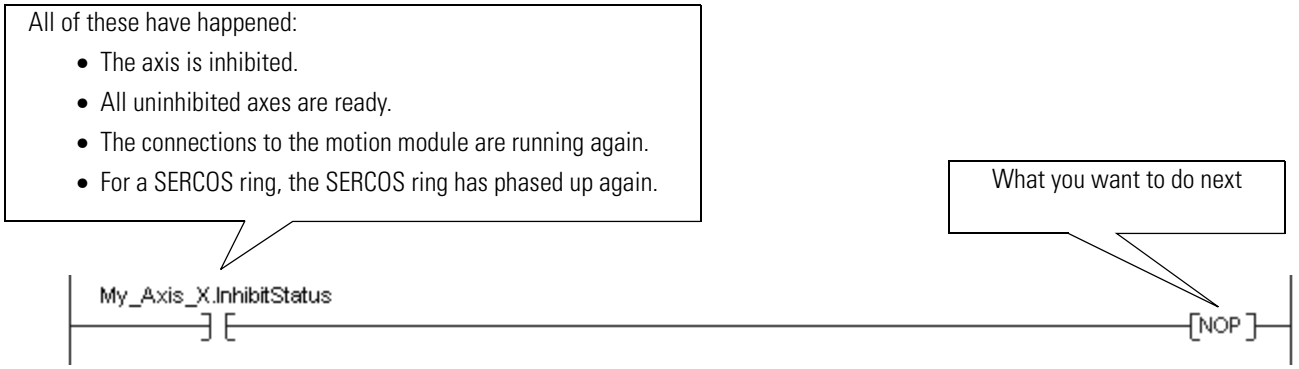
2. **Use a one shot instruction to trigger the inhibit.**



3. **Inhibit the axis.**

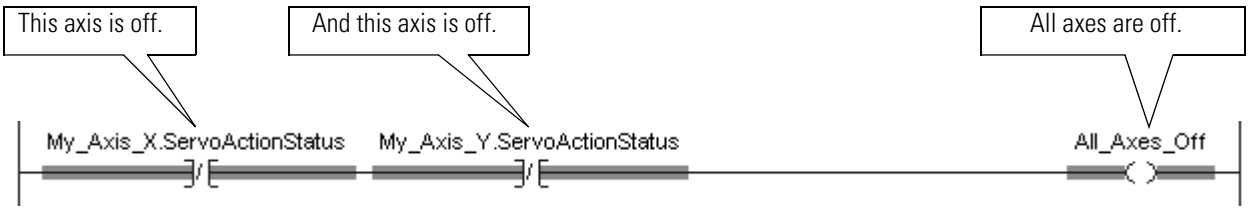


4. **Wait for the inhibit process to finish.**

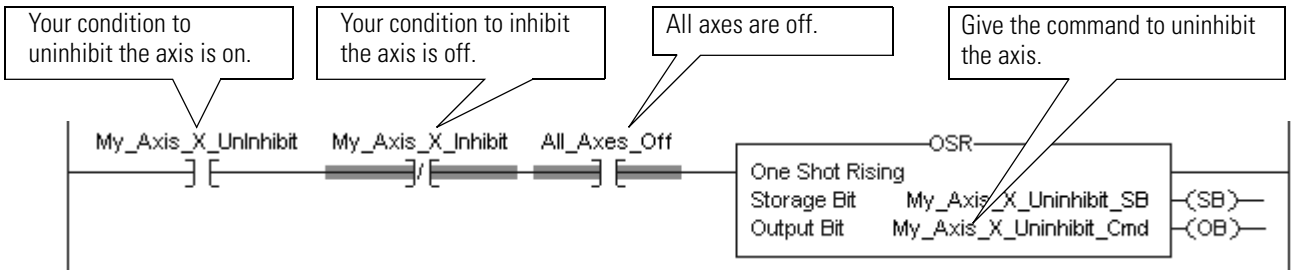

All of these have happened:
• The axis is inhibited.
• All uninhibited axes are ready.
• The connections to the motion module are running again.
• For a SERCOS ring, the SERCOS ring has phased up again.
What you want to do next
My_Axis_X.InhibitStatus
NOP

Example: Uninhibit an Axis

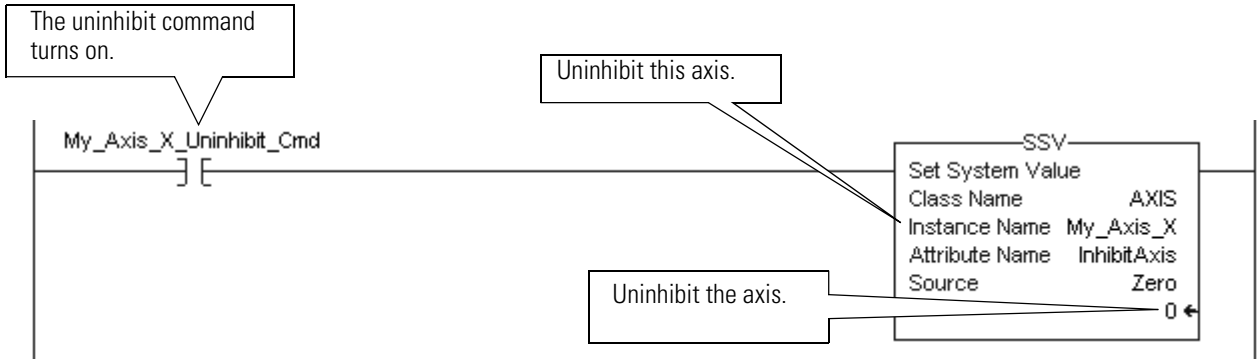
1. **Make sure all exes are off.**



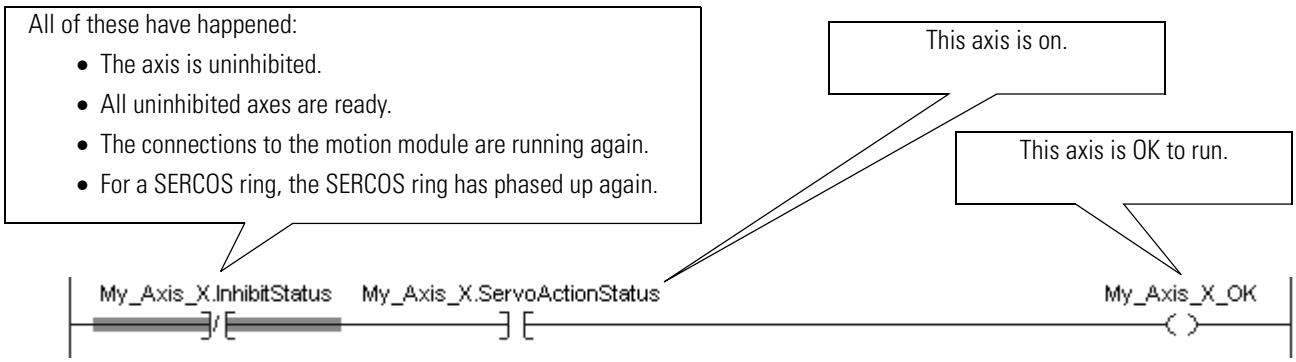
2. **Use a one shot instruction to trigger the uninhibit.**



3. **Uninhibit the axis.**



4. **Wait for the inhibit process to finish.**


All of these have happened:
• The axis is uninhibited.
• All uninhibited axes are ready.
• The connections to the motion module are running again.
• For a SERCOS ring, the SERCOS ring has phased up again.
This axis is on.
This axis is OK to run.
My_Axis_X.InhibitStatus
My_Axis_X.ServoActionStatus
My_Axis_X_OK

Specifications and Performance

This appendix shows specifications and performance guidelines for the motion modules.

1756-M02AE Motion Module

Number of axes per chassis	Configurable
Motion commands	32
Number of axes per module	2 axes maximum
Servo loop	
Type	Nested PI digital position and velocity servo
Gain resolution	32-bit floating point
Absolute position range	±1,000,000,000 encoder counts
Rate	5 kHz
Module location	1756 ControlLogix chassis
Module keying	Electronic
Power dissipation	5.5W maximum
Backplane current	5V dc @ 700 mA 24V dc @ 2.5 mA
Encoder input	
Type	Incremental AB quadrature with marker
Mode	4X quadrature
Rate	4 MHz counts per second maximum
Electrical interface	Optically isolated 5V differential
Voltage range	
On state	3.4V to 5.0V
Off state	0V to 1.8V
Input impedance	531 Ohms differential
Registration inputs	
Type	Optically isolated, current sourcing input
24V input voltage	+24V dc nominal
Maximum	26.4V
Minimum on	18.5V
Maximum off	3.5V
5V input voltage	+5V dc nominal
Maximum	5.5V
Minimum on	3.7V
Maximum off	1.5V
Input impedance	
24V input	9.5 kOhms
5V input	1.2 kOhms
Response time (position latched)	1µs

All other inputs	
Type	Optically isolated, current sinking input
Input voltage	+24V dc nominal
Maximum	26.4V
Minimum on	17.0V
Maximum off	8.5V
Input impedance	7.5 kOhms
Servo output	
Type	Analog voltage
Isolation	200 kOhms
Voltage range	±10V
Voltage resolution	16 bits
Load	5.6 kOhms resistive minimum
Maximum offset	25 mV
Gain error	±4%
All other outputs	
Type	Solid-state isolated relay contacts
Operating voltage	+24V dc nominal
Maximum	26.4V
Operating current	75 mA
RTB keying	User-defined
Field wiring arm	36-position RTB (1756-TBCH or -TBS6H)[1]
RTB screw torque (cage clamp)	5lb-in. (0.5 Nm) maximum
Conductors	
Wire size	22 gauge (3.1 mm^2) minimum to copper[1] 3/64 inch (1.2 mm) insulation maximum
Category	1[2,3]
Screwdriver blade width for RTB	1/8 inch (3.2 mm) maximum
Environmental conditions	
Operating temperature	0 to 60°C (32 to 140°F)
Storage temperature	-40 to 85°C (-40 to 185°F)
Relative humidity	5 to 95% noncondensing
Agency certification (when product or packaging is marked)	UL® CSA Class 1, Division 2, hazardous location CE marked for all applicable directives

[1] Maximum wire size will require the extended depth RTB housing (1756-TBE).

[2] Use this conductor category information for planning conductor routing as described in the system level installation manual.

[3] Refer to *Industrial Automation Wiring and Grounding Guidelines*, publication number 1770-4.1.

1756-HYD02 Motion Module

Number of axes	2 axes maximum
Servo loop Type Gain resolution Absolute position range Rate	 Proportional, integral and differential (PID) with Feed-Forwards and Directional scaling 32- bit floating point 230,000 LDT counts 500Hz to 4kHz (Selectable)
Module location	1756 ControlLogix chassis
Module keying	Electronic
Power dissipation	5.5W maximum
Thermal dissipation	18.77 BTU/hr
Backplane current	5.1V dc @ 700mA and 24V dc @ 2.5mA
LDT input Type Resolution Electrical Interface Input impedance Output Load Transducer	 PWM, Start/Stop rising or falling edge less than 0.001 inch with single recirculation Isolated 5V differential (RS-422 signal) 215 Ohm differential 100 Ohm minimum Must use External Interrogation signal
Registration inputs Type 24V dc input voltage Maximum on Minimum on Maximum off 5V dc input voltage Maximum on Minimum on Maximum off Input impedance 24V dc input 5V dc input Response time (position latched)	 Optically isolated, current sinking input +24V dc nominal 26. 4V dc 18. 5V dc 3.5V dc +5V dc nominal 5.5V dc 3.7V dc 1.5V dc 9.5 kΩ 1.2 kΩ 1 servo update period - Servo update period is the period at which the position and/or velocity feedback is sampled and a new servo loop is closed to generate a new servo output. The time of this period is a user-defined setting from 250µs to 2000µs.
All other inputs Type Input voltage Maximum on Minimum on Maximum off Input impedance	 Optically isolated, current sinking input +24V dc nominal 26. 4V dc 17. 0V dc 8.5V dc 7.5 kΩ

Servo output Type Voltage range Voltage resolution Load Maximum offset Gain error	 Analog voltage ±10V dc 16 bits 5.6 kOhms resistive minimum 25 mV ±4%
All other outputs Type Operating voltage Maximum Operating current	 Solid-state isolated relay contacts +24V dc nominal 26. 4V dc 75 mA
Isolation Voltage User to System	 30V continuous
RTB keying	User-defined
Field wiring arm	36-position RTB (1756-TBCH or -TBS6H)(1)
RTB screw torque (cage clamp)	4.4 inch-pounds (0.4Nm) maximum
Conductors Wire size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded(1) 3/ 64 inch (1.2 mm) insulation maximum 2(2), (3)
Screwdriver blade width for RTB	1/8 inch (3.2mm) maximum
Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): Operating 30g Non-operating 50g
Emissions	CISPR 11: Group 1, Class A

ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 80MHz to 2000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth (CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications (when product is marked)	UL UL Listed Industrial Control Equipment CSACSA Certified Process Control Equipment CSACSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations CE[4]European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[4]Australian Radiocommunications Act, compliant with: AS/NZS 2064; Industrial Emissions

(1) Maximum wire size requires the extended-depth RTB housing (1756-TBE).

(2) Use the conductor category information for planning conductor routing as described in the system level installation manual.

(3) Refer to Industrial Automation Wiring and Grounding Guidelines, publication number 1770-4.1.

(4) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-M02AS Motion Module

Number of axes	2 axes maximum
Servo loop Type Gain resolution Absolute position range Rate	 Nested PI digital position and velocity servo with hydraulics support 32- bit floating point 2^{32} (4,294,967,296) transducer counts 500Hz, 666.7Hz, 1kHz, 2kHz, 4kHz (Selectable)
Module location	1756 ControlLogix chassis
Module keying	Electronic
Power dissipation	5.5W maximum
Thermal dissipation	18.77 BTU/hr
Backplane current	5.1V dc @ 700mA and 24V dc @ 2.5mA
SSI input Type Resolution Electrical Interface Input impedance Output Load Transducer Clock Frequency	 Synchronous Serial Interface 8 to 31 Bits Isolated 5V differential (RS-422 signal) 215 Ohm differential 100 Ohm minimum Binary or Gray code 208kHz or 625kHz
Registration inputs Type 24V dc input voltage Maximum Minimum on Maximum off 5V dc input voltage Maximum Minimum on Maximum off Input impedance 24V dc input 5V dc input Response time (position latched)	 Optically isolated, current sinking input +24V dc nominal 26. 4V dc 18. 5V dc 3.5V dc +5V dc nominal 5.5V dc 3.7V dc 1.5V dc 9.5 kΩ 1.2 kΩ 1 servo update period - Servo update period is the period at which the position and/or velocity feedback is sampled and a new servo loop is closed to generate a new servo output. The time of this period is a user-defined setting from 250μs to 2000μs.
All other inputs Type Input voltage Maximum Minimum on Maximum off Input impedance	 Optically isolated, current sinking input +24V dc nominal 26. 4V dc 17. 0V dc 8.5V dc 7.5 kΩ

Servo output Type Voltage range Voltage resolution Load Maximum offset Gain error	 Analog voltage ±10V dc 16 bits 5.6 kOhms resistive minimum 25 mV ±4%
All other outputs Type Operating voltage Maximum Operating current	 Solid-state isolated relay contacts +24V dc nominal 26. 4V dc 75 mA
Isolation Voltage User to System	 30V continuous
RTB keying	User-defined
Field wiring arm	36-position RTB (1756-TBCH or -TBS6H)(1)
RTB screw torque (cage clamp)	4.4 inch-pounds (0.4Nm) maximum
Conductors Wire size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded(1) 3/ 64 inch (1.2 mm) insulation maximum 2(2), (3)
Screwdriver blade width for RTB	1/8 inch (3.2mm) maximum
Environmental Conditions	
Operating Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): 0 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): –40 to 85°C (–40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Shock	IEC60068-2-27 (Test Ea, Unpackaged shock): Operating 30g Non-operating 50g
Emissions	CISPR 11: Group 1, Class A

ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 80MHz to 2000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz
EFT/B Immunity	IEC 61000-4-4: ±2kV at 5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±2kV line-earth (CM) on shielded ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Enclosure Type Rating	None (open-style)
Certifications (when product is marked)	UL UL Listed Industrial Control Equipment CSACSA Certified Process Control Equipment CSACSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations CE[4] European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick[4] Australian Radiocommunications Act, compliant with: AS/NZS 2064; Industrial Emissions

(1) Maximum wire size requires the extended-depth RTB housing (1756-TBE).

(2) Use the conductor category information for planning conductor routing as described in the system level installation manual.

(3) Refer to Industrial Automation Wiring and Grounding Guidelines, publication number 1770-4.1.

(4) See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

1756-M03SE, 1756-M08SE, & 1756-M16SE Motion Module

Specifications

Description	Value	
Power Dissipation	5.0W	
Backplane Current	760 mA @ 5.1V dc	
	2.5 mA @ 24V dc	
Operational Temperature	IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock): • 0 to 60°C (32 to 140°F)	
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): • -40 to 85°C (-40 to 185°F)	
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): • 5 to 95% non-condensing	
Vibration	IEC 60068-2-6 (Test Fc, Operating): • 2g @ 10-500Hz	
Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): • 30g	
Non-Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): • 50g	
Emissions	CISPR 11: Group 1, Class A	
ESD Immunity	IEC 61000-4-2: • 4kV contact discharges • 8kV air discharges	
Radiated RF Immunity	IEC 61000-4-3: • 10V/m with 1kHz sine-wave 80%AM from 80MHz to 2000MHz • 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz • 10V/m with 200Hz 50% Pulse 100%AM at 1890Mhz	
Enclosure Type Rating	None (open-style)	
Number of Drives	1756-M03SE	Up To 3 SERCOS interface drives
	1756-M08SE	Up to 8 SERCOS interface drives
	1756-M16SE	Up to 16 SERCOS interface drives
SERCOS interface Data Rate	1756-M03SE	4 Mbits or 8 Mbits per second
	1756-M08SE	4 Mbits or 8 Mbits per second
	1756-M16SE	4 Mbits or 8 Mbits per second

Description	Value		
SERCOS interface Cycle Time	**Important**: Only Kinetix 6000 drives let you use a 0.5 ms cycle time.		
	Data rate	**Number of drives**	**Cycle time**
	4 Mb	up to 2	0.5 ms
		up to 4	1 ms
		up to 8	2 ms
		You can't use more than 8 drives at a 4 Mb data rate.	
	8 Mb	up to 4	0.5 ms
		up to 8	1 ms
		up to 16	2 ms
Plastic Fiber Optic Cable	Transmission Range	1-32 meters	
	Core Diameter	980µm ±60µm	
	Cladding Diameter	1000µm ±60µm	
	Cable Attenuation	140 dB/km @ 650nm	
	Operating Temperature	-55 to 85° C	
	Connector	F-SMA standard screw-type connector	
	Bend Radius	2.5 cm	
Glass Fiber Optic Cable	Transmission Range	1-200 meters	
	Core Diameter	200µm ±4µm	
	Cladding Diameter	230µm +0 / −10µm	
	Cable Attenuation	6.0 dB/km @ 820nm	
	Operating Temperature	-20 to 85° C	
	Connector	F-SMA standard screw-type connector	
	Bend Radius	2.5cm	

Certifications

When marked, the module has the following certifications. See the Product Certification link at www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Certification	Description
c-UL-us	UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada
CE	European Union 89/336/EEC EMC Directive, compliant with: • EN 50082-2; Industrial Immunity • EN 61326; Meas./Control/Lab., Industrial Requirements • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions
C-Tick	Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions

Loop and Interconnect Diagrams

This appendix shows the loop interconnect diagrams for common motion configurations.

Understanding Block Diagrams

The control block diagrams in this section use the following terms for motion attributes.

Diagram term	Motion attribute name (as used in the GSV and SSV instructions)
Acc FF Gain	AccelerationFeedforwardGain
Vel FF Gain	VelocityFeedforwardGain
Pos P Gain	PositionProportionalGain
Pos I Gain	PositionIntegralGain
Vel P Gain	VelocityProportionalGain
Vel I Gain	VelocityIntegralGain
Output Filter BW	OutputFilterBandwidth
Output Scaling	OutputScaling
Friction Comp	FrictionCompensation
Output Limit	OutputLimit
Output Offset	OutputOffset
Position Error	PositionError
Position Integrator Error	PositionIntegratorError
Velocity Error	VelocityError
Velocity Integrator Error	VelocityIntegratorError
Velocity Feedback	VelocityFeedback
Velocity Command	VelocityCommand
Servo Output Level	ServoOutputLevel
Registration Position	RegistrationPosition
Watch Position	WatchPosition

Using a 1756-M02AE Module With a Torque Servo Drive

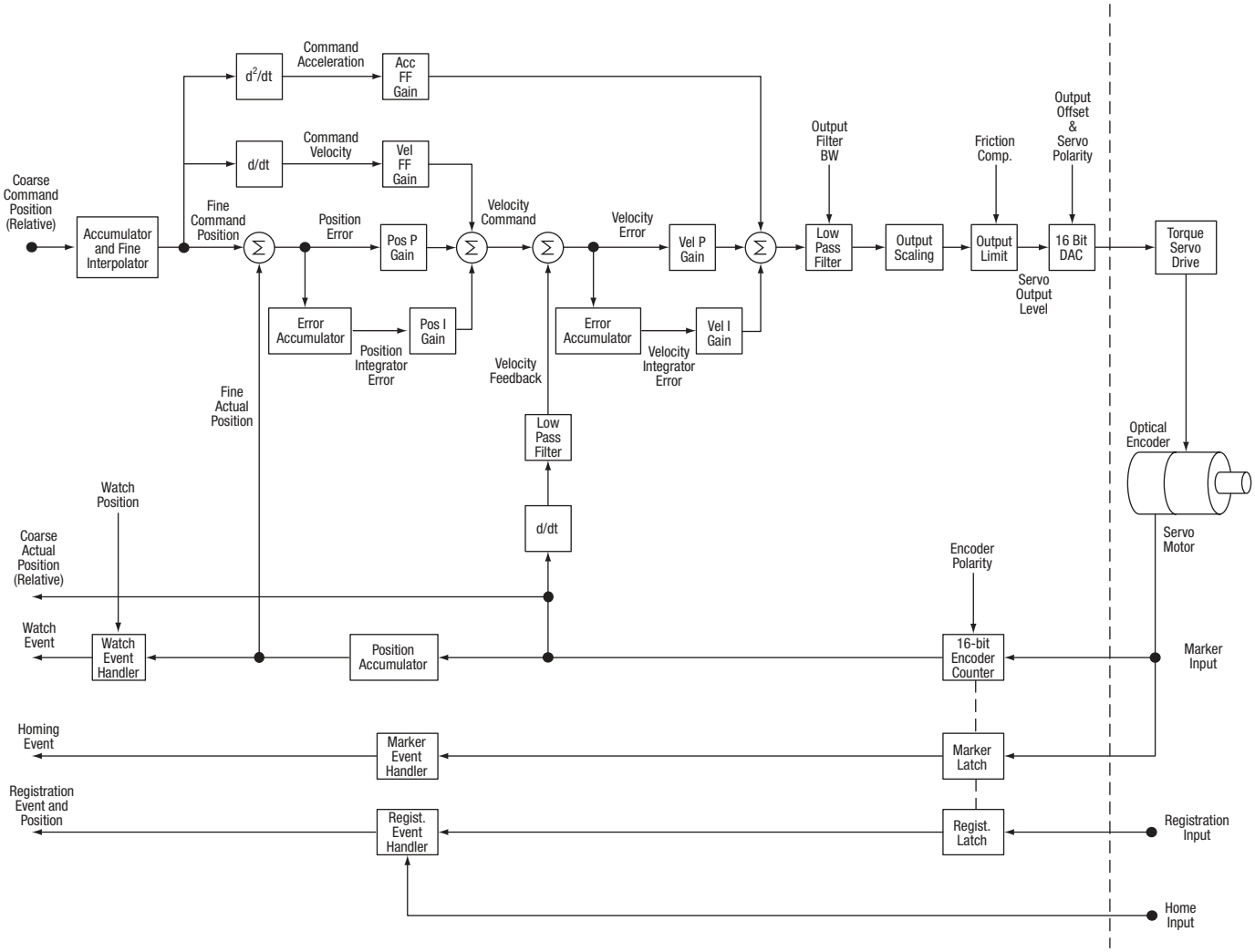


Figure B.1 Torque Servo Drive

Using a 1756-M02AE Module With a Velocity Servo Drive

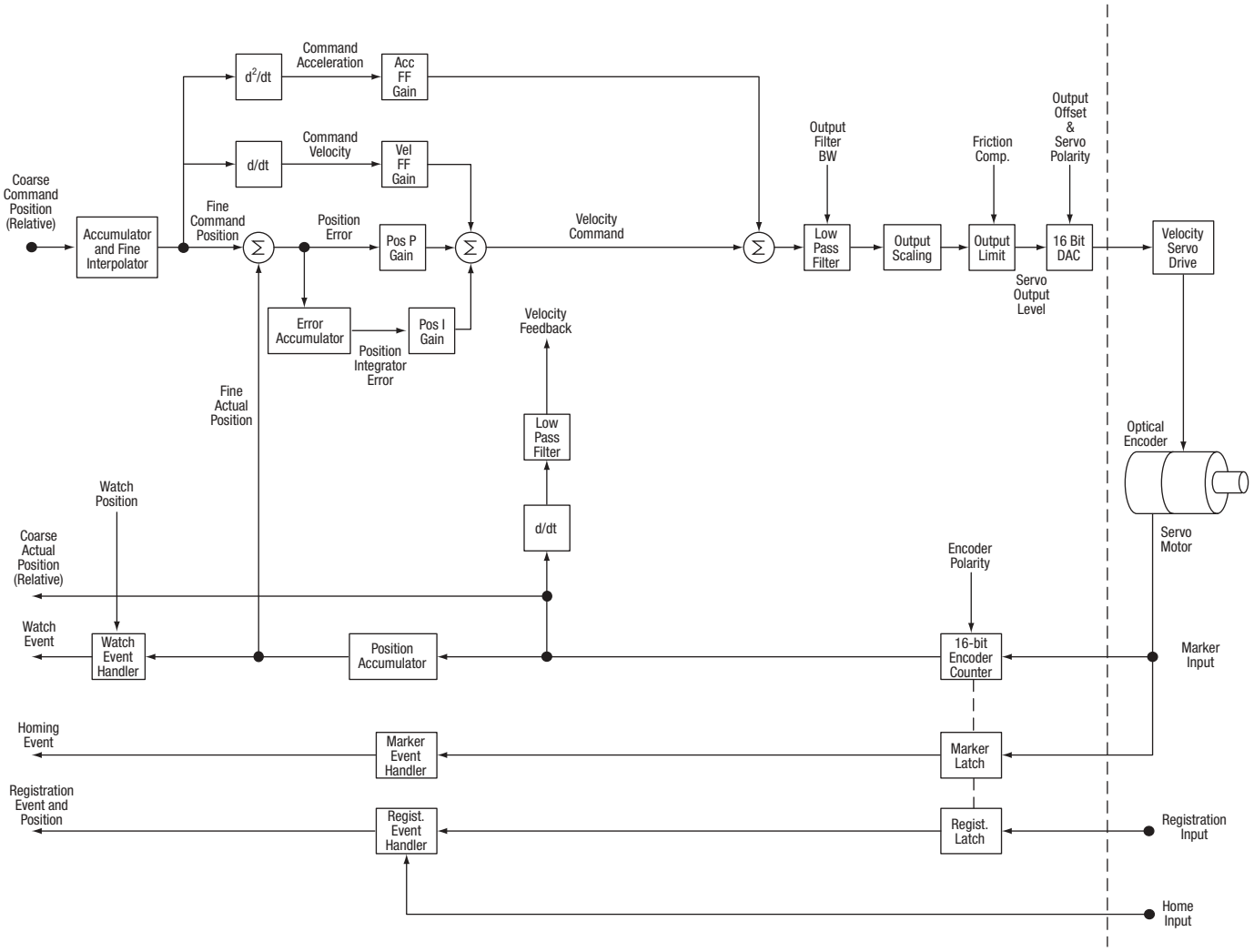


Figure B.2 Velocity Servo Drive

Understanding Wiring Diagrams

Wiring to a Servo Module RTB

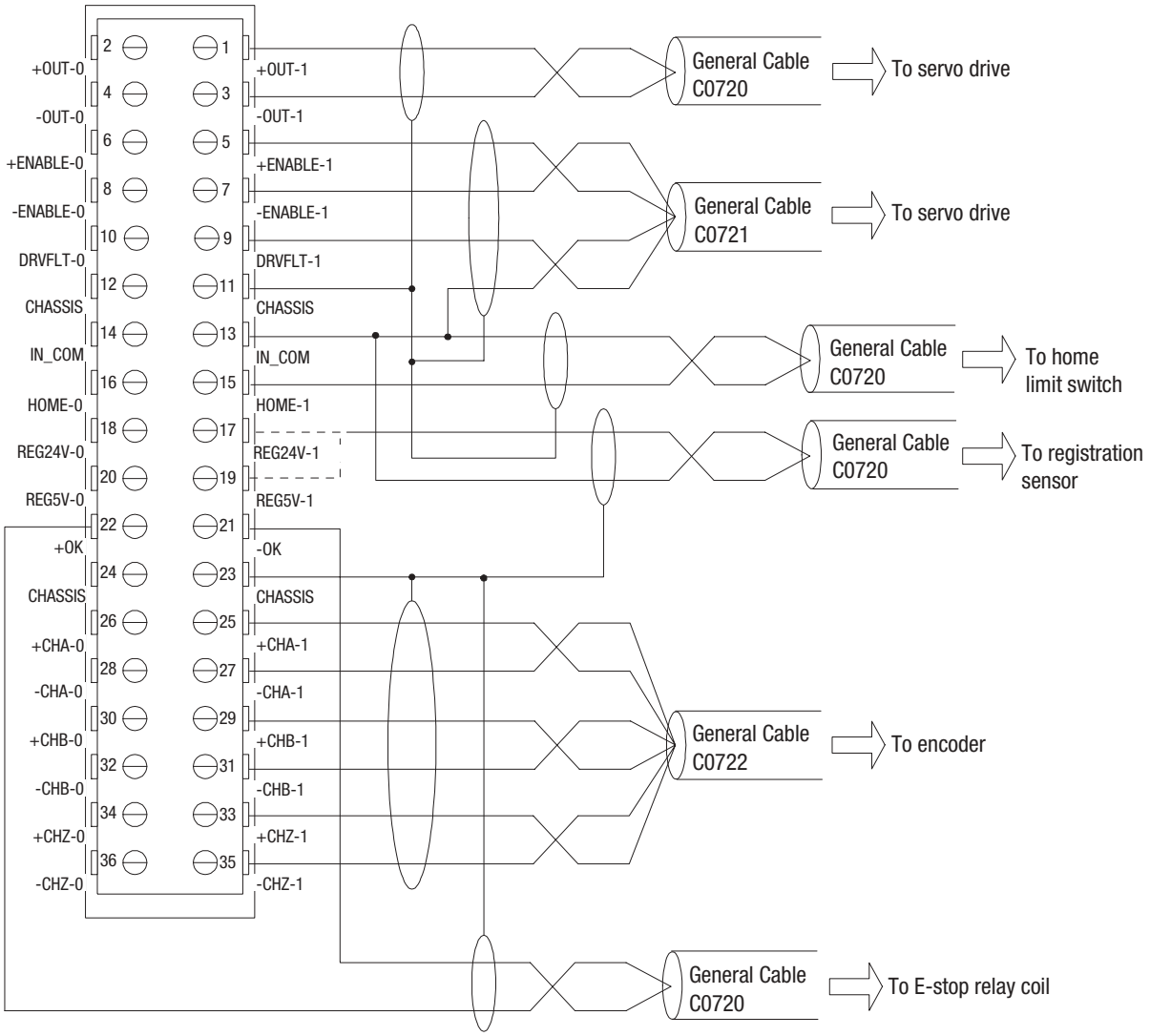


Figure B.3 Wiring to a RTB

This is a general wiring example illustrating Axis 1 wiring only. Other configurations are possible with Axis 0 wiring identical to Axis 1.

Wiring to an Ultra 100 Series Drive

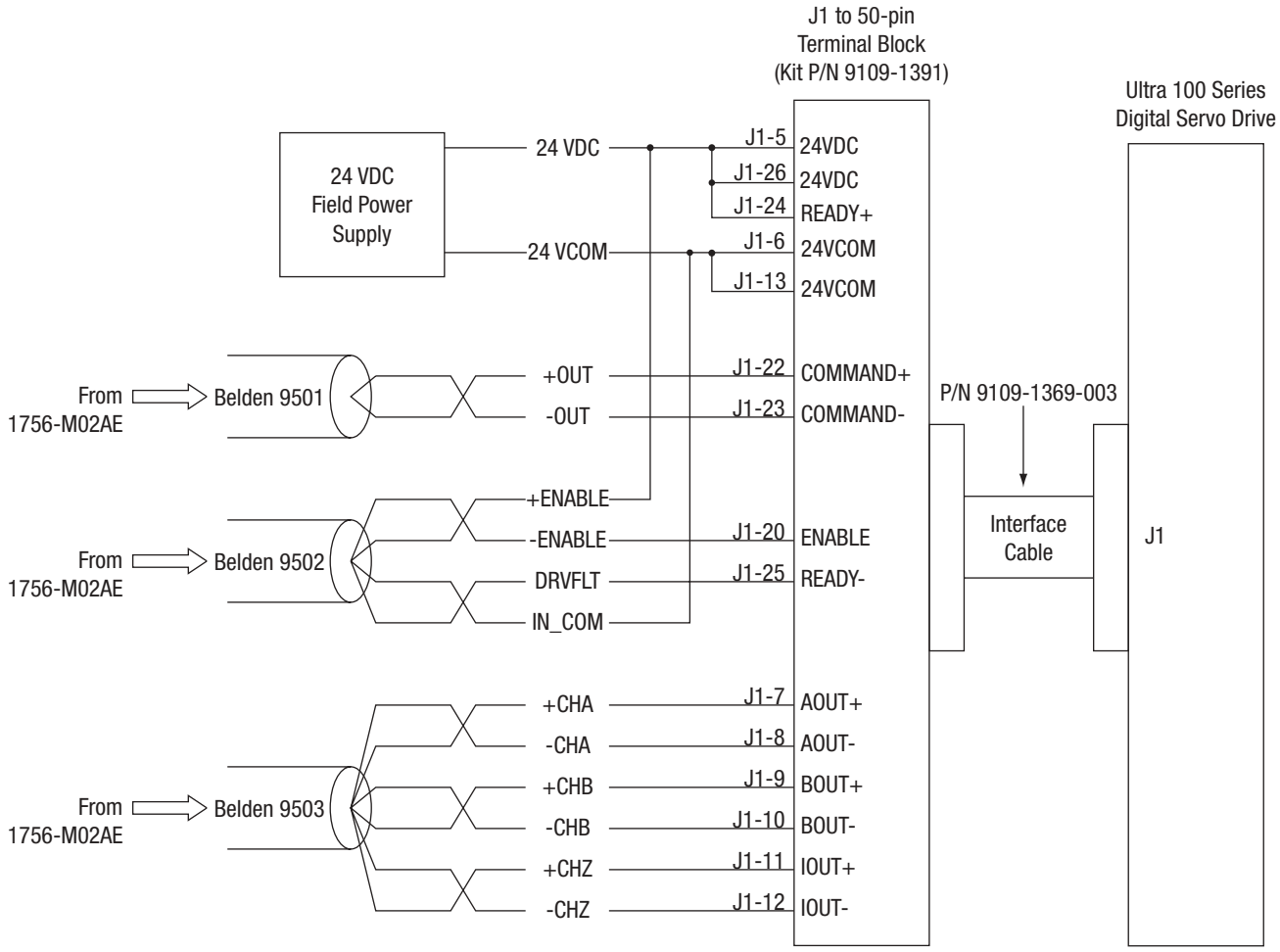


Figure B.4 Wiring the Ultra 100

This is a general wiring example only. Other configurations are possible. For more information, refer to the *Ultra 100 Series Drive Installation Manual*, publication number 1398-5.2.

Wiring to an Ultra 200 Series Drive

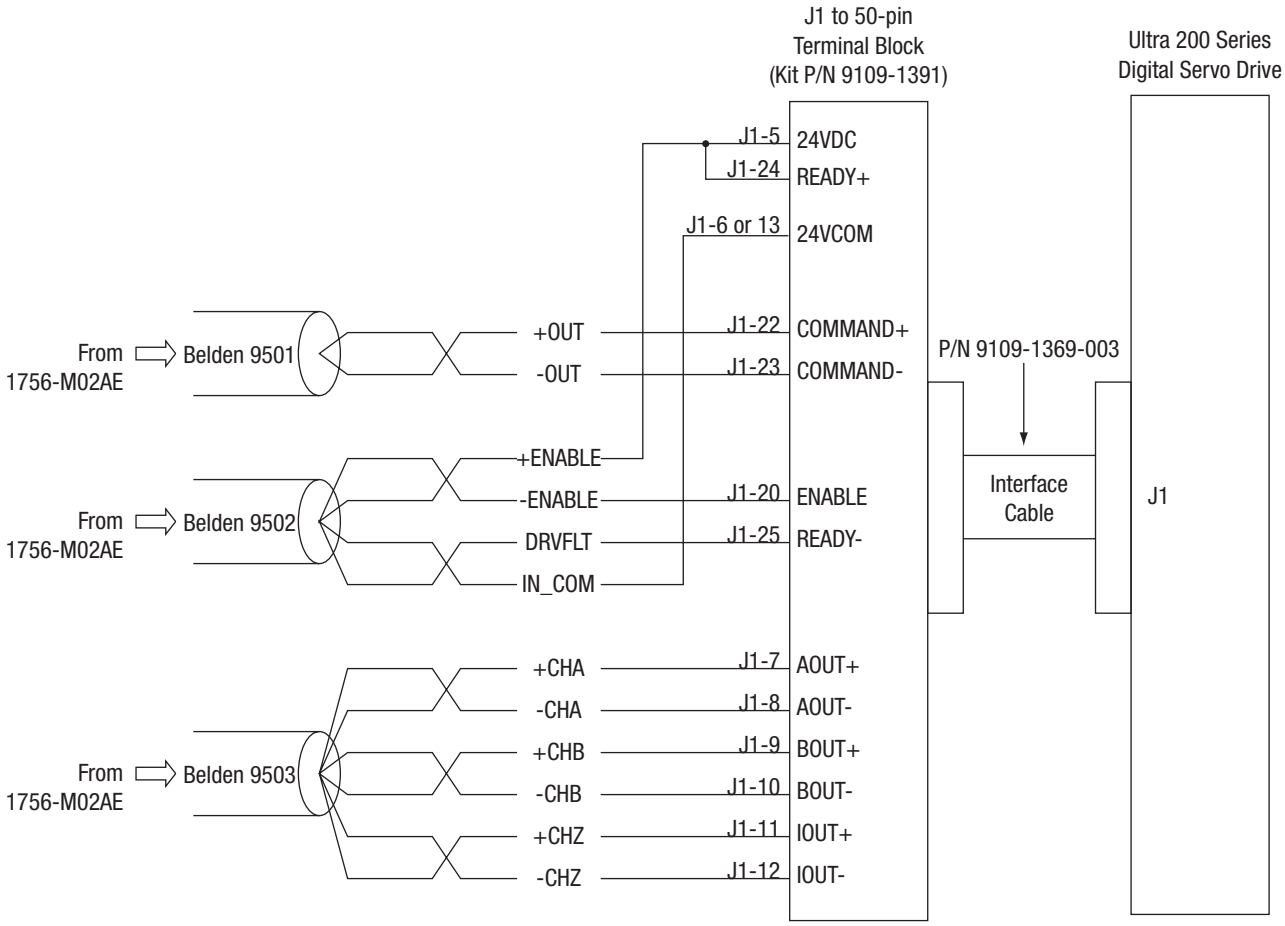


Figure B.5 Wiring the Ultra 200

This is a general wiring example only. Other configurations are possible. For more information, refer to the *Ultra 200 Series Drive Installation Manual*, publication number 1398-5.0.

1398-CFLAExx Cable Diagram

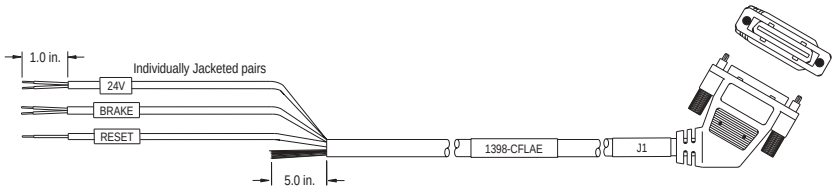


Figure B.6 1398 Cable Diagram

The 1398-CFLAE Cable is available in 3 ft. (.76 m) 10 ft. (2.5 m), 25 ft. (7.6 m), and 50 ft. (12.7 m) lengths.

Pinouts for 1398-CFLAExx Cable

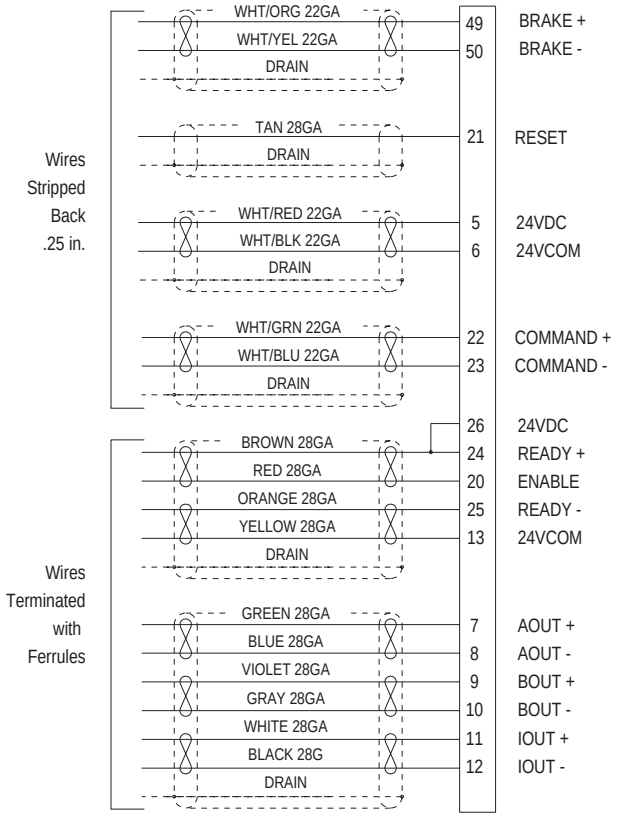


Figure B.7 1398-CFLAExx Cable

Wiring the Ultra3000 Drive

This section helps you to wire the Ultra3000 drive to the 1756-M02AE. The following diagram shows the 2090-U3AE-D44*xx* Cable.

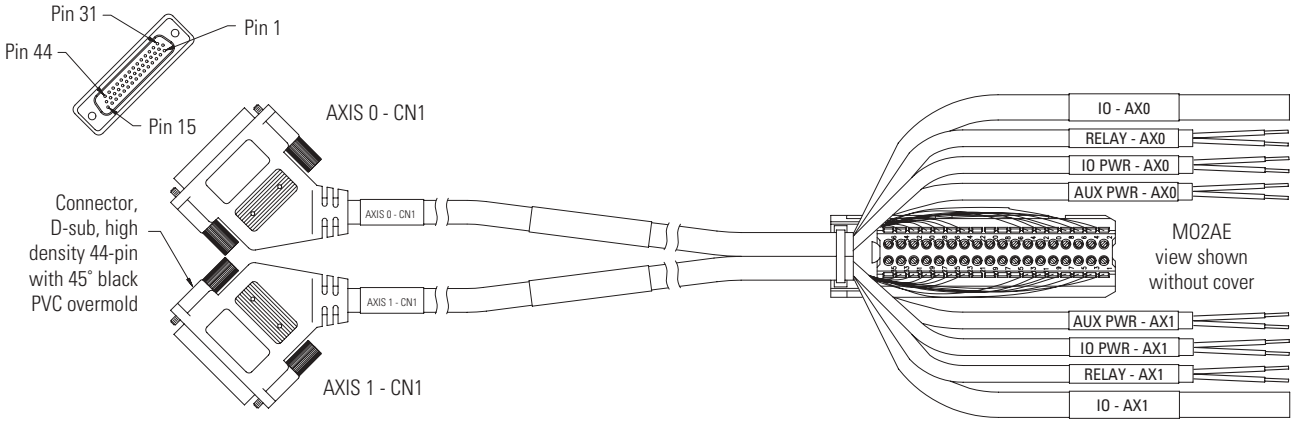


Figure B.8 2090-U3AE-D44xx Cable

The next diagram is the Ultra3000 to 1756-M02AE Interconnect diagram.

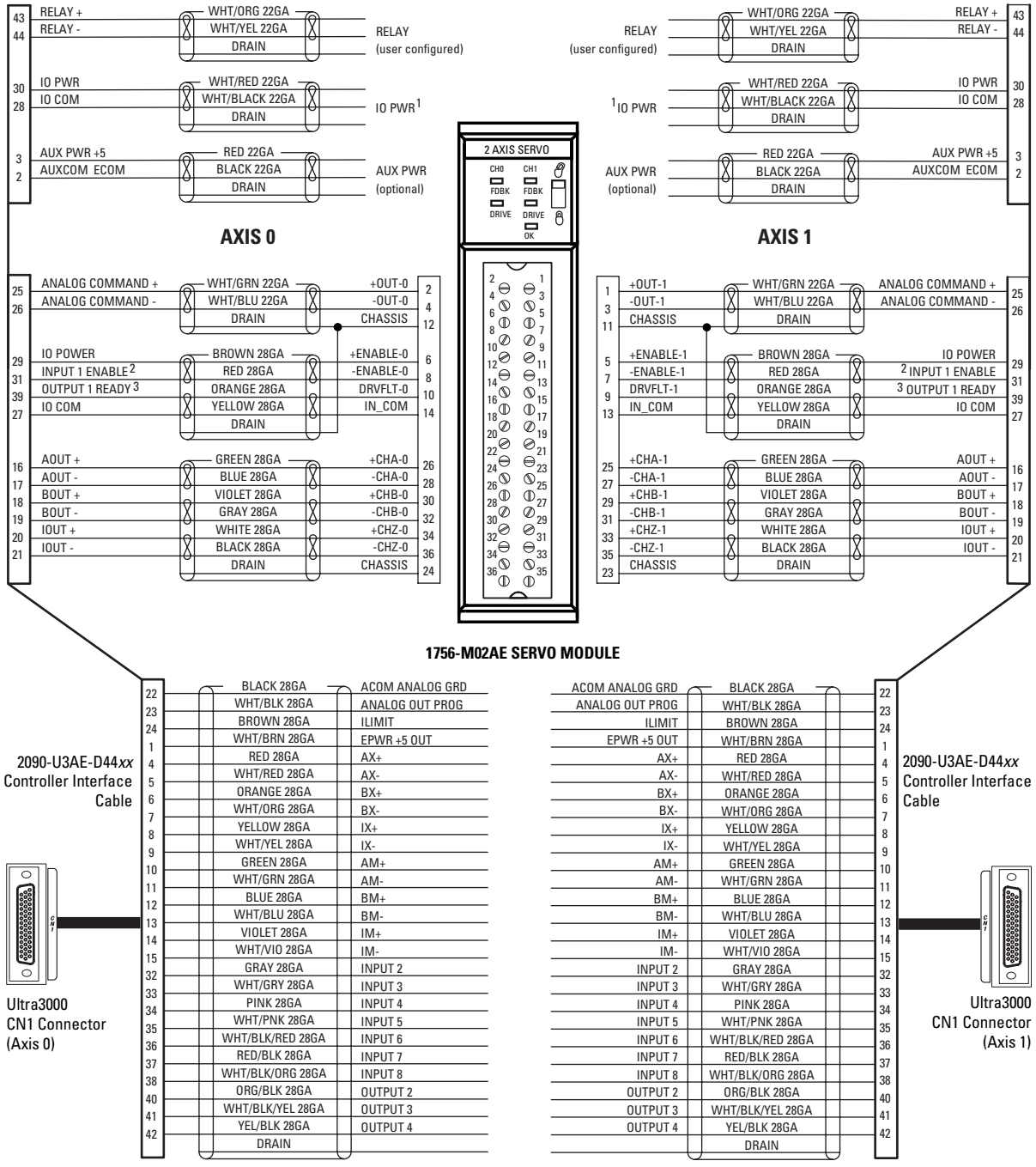


Figure B.9 Ultra3000 Interconnect Diagram

This is a general wiring example only. For more information, refer to the *Ultra3000 Digital Servo Drives Installation Manual*, publication number 2098-IN003.

Wiring to a 1394 Servo Drive (in Torque Mode only)

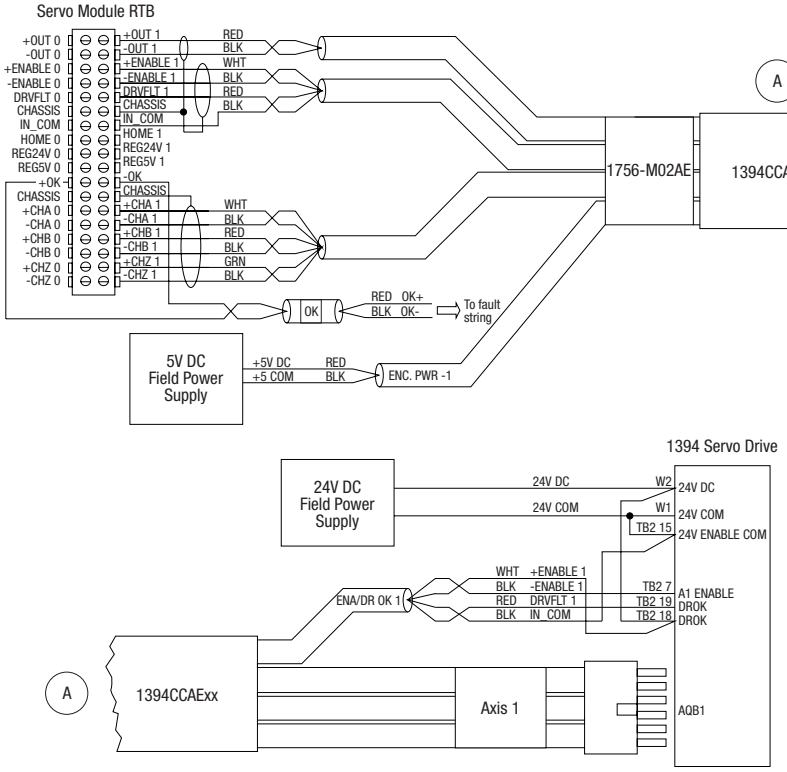


Figure B.10 1394 Servo Drive in Torque Mode

The wiring diagram illustrates Axis 1 wiring only. Other configurations are possible.

The 1394CCAE*xx* cable is wired to connect to torque command reference input pins.

An external +5V power supply is required to power the encoder driver circuit of the 1394 servo drive. Because this connection is shared by all four axis encoder driver circuits, only one connection is needed to the +5V field supply.

The *xx* in the cable number is the length of the cable.

The 1394-CFLAE*xx* Cable Wiring Diagram

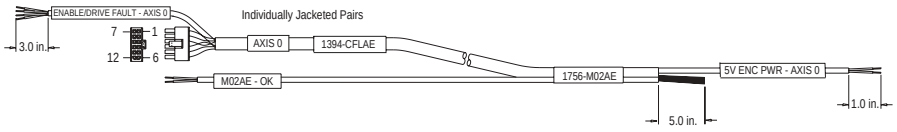


Figure B.11 1394-CFLAE*xx* Cable Wiring

The 1394-CFLAE cable is available in 1 m (3.28 ft.), 3 m (9.84 ft.), 8 m (26.25 ft.), and 15 m (49.26 ft.) lengths.

Pinouts for the 1394-CFLAE

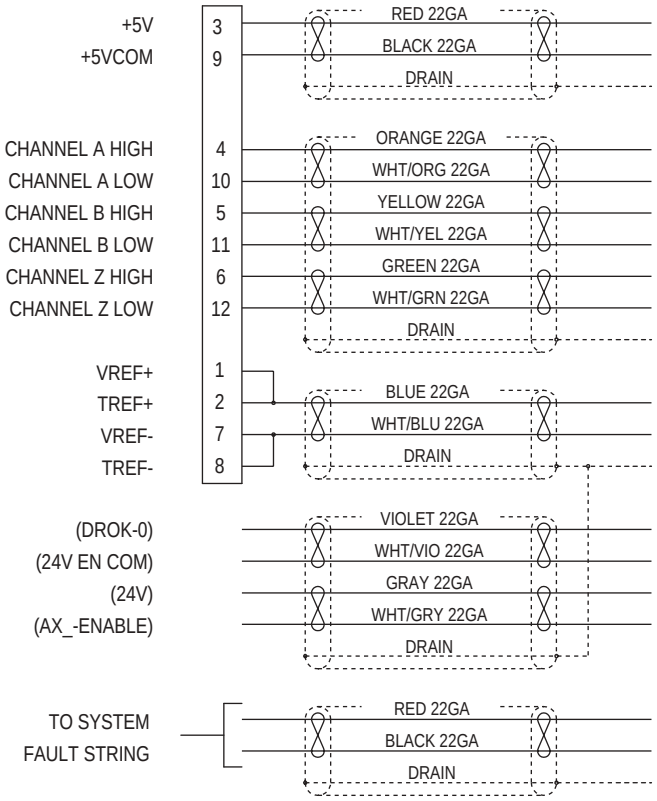


Figure B.12 1394-CFLAE Pinouts

Wiring Registration Sensors

The registration inputs to the servo module can support 24V or 5V registration sensors. These inputs should be wired to receive source current from the sensor. Current sinking sensor configurations are not

allowed because the registration input common (IN_COM) is shared with the other 24V servo module inputs.

24V Registration Sensor

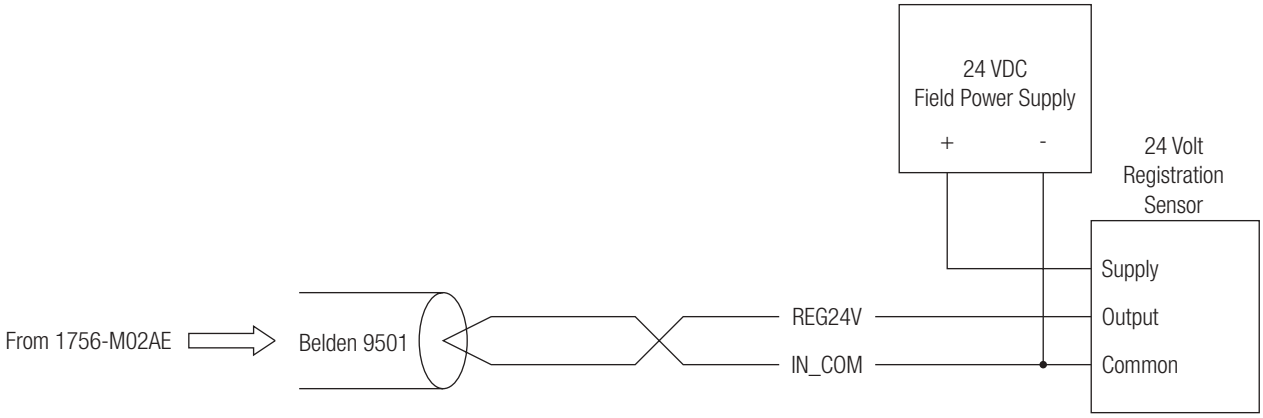


Figure B.13 24V Registration Sensor

5V Registration Sensor

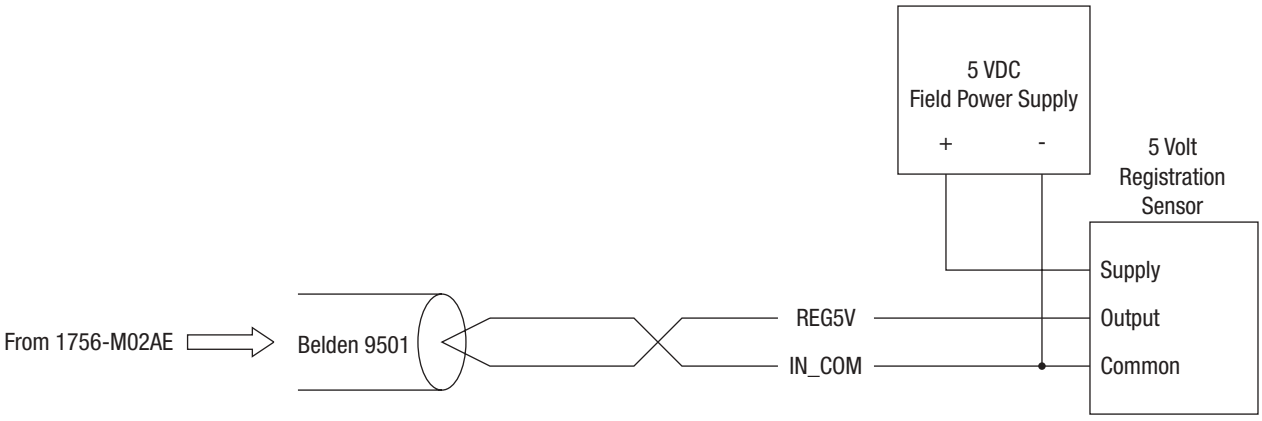


Figure B.14 5V Registration Sensor

Wiring the Home Limit Switch Input

The home limit switch inputs to the servo module are designed for 24V nominal operation. These inputs should be wired for current sourcing operation.

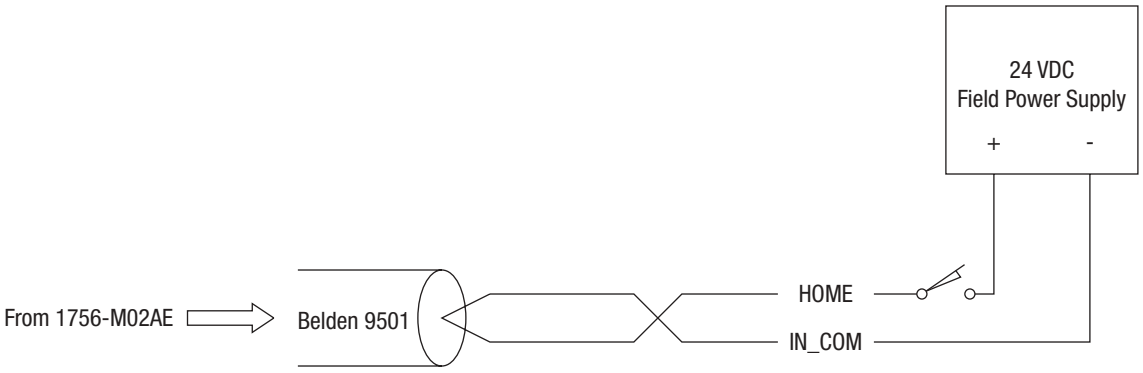


Figure B.15 Home Limit Switch Wiring

Wiring the OK Contacts

A set of isolated solid-state OK relay contacts is provided for optional interface to an E-stop string, which controls power to the associated drives. The OK contacts are rated to drive an external 24V pilot relay (for example, Allen-Bradley 700-HA32Z24) whose contacts can be incorporated into the E-Stop string as shown below.

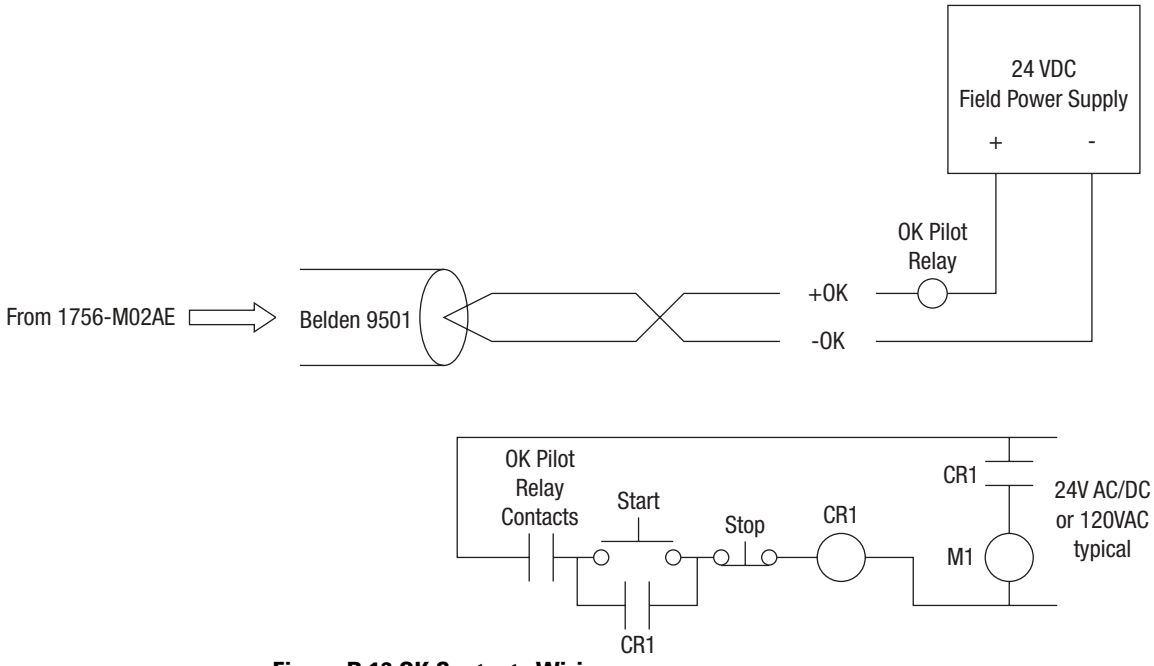


Figure B.16 OK Contacts Wiring

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Rockwell Automation Support

Rockwell Automation provides technical information on the web to assist you in using its products. At http://support.rockwellautomation.com, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration and troubleshooting, we offer TechConnect Support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://support.rockwellautomation.com.

Installation Assistance

If you experience a problem with a hardware module within the first 24 hours of installation, please review the information that's contained in this manual. You can also contact a special Customer Support number for initial help in getting your module up and running:

United States	1.440.646.3223 Monday – Friday, 8am – 5pm EST
Outside United States	Please contact your local Rockwell Automation representative for any technical support issues.

New Product Satisfaction Return

Rockwell tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned:

United States	Contact your distributor. You must provide a Customer Support case number (see phone number above to obtain one) to your distributor in order to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for return procedure.

www.rockwellautomation.com

Corporate Headquarters
Rockwell Automation, 777 East Wisconsin Avenue, Suite 1400, Milwaukee, WI, 53202-5302 USA, Tel: (1) 414.212.5200, Fax: (1) 414.212.5201

Headquarters for Allen-Bradley Products, Rockwell Software Products and Global Manufacturing Solutions
Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation SA/NV, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Headquarters for Dodge and Reliance Electric Products
Americas: Rockwell Automation, 6040 Ponders Court, Greenville, SC 29615-4617 USA, Tel: (1) 864.297.4800, Fax: (1) 864.281.2433
Europe/Middle East/Africa: Rockwell Automation, Herman-Heinrich-Gossen-Strasse 3, 50858 Köln, Germany, Tel: 49 (0) 2234 379410, Fax: 49 (0) 2234 3794164
Asia Pacific: Rockwell Automation, 55 Newton Road, #11-01/02 Revenue House, Singapore 307987, Tel: (65) 6356 9077, Fax: (65) 6356 9011

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Allen-Bradley

Logix5000™ Motion Modules

User Manual